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Power

the magazine of energy systems engineering

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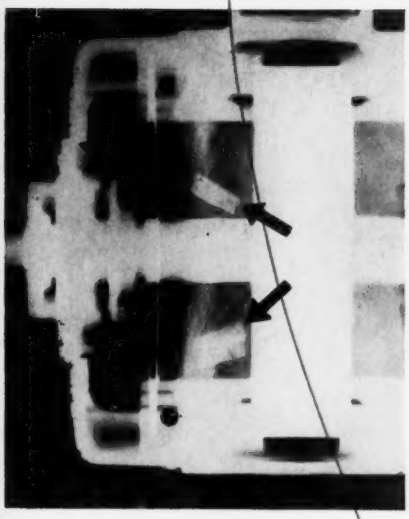


◀ Protect motors by temperature sensing 59

A plan for complete supervisory control 64

Why piston-diaphragm pumps aid metering.68

Calculate pipe-friction losses—fast.....70

Stainless-steel stack goes up in one piece....72

Process steam from nuclear reactors.....73

Pin down freezing point of heating coils 88

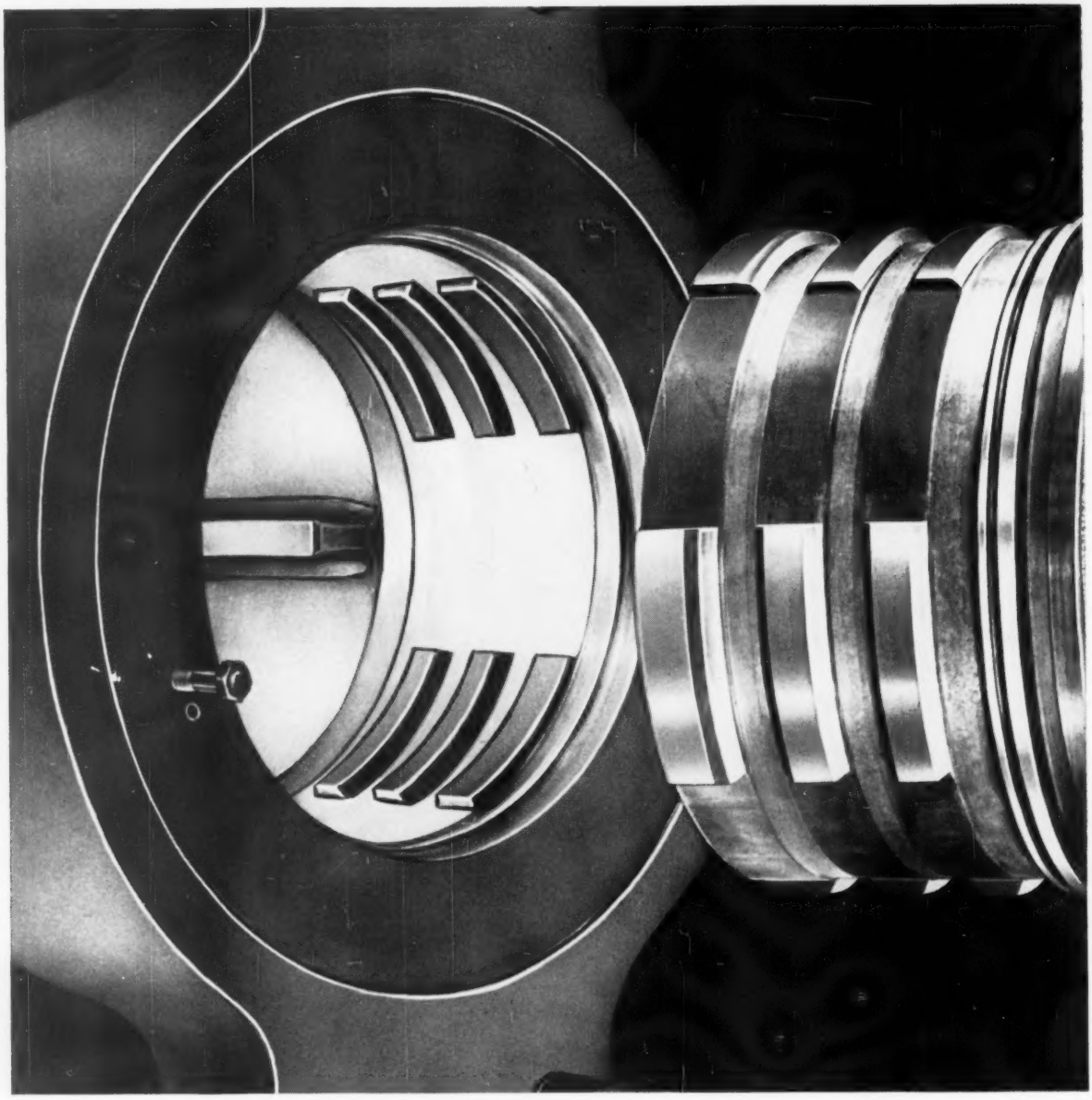
Magnetic plugs can protect against wear....188

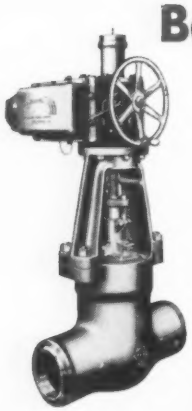
The high cost of low air pressure 190

How Rohr Aircraft cuts downtime.....193

Maintenance tips on high-voltage bushings .196

ELECTRICAL SAFETY:
Are problems mounting? ▸ 183





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speaking of **Power**

A series of articles, each neatly compartmented and reasonably complete in itself, is often the most practical way to present lengthy information on a given subject. We have published many such series, covering many energy systems, in the pages of POWER. Some of these tidy individual packages later have been gathered together into book form.

Typical of series now in more permanent binding is "How to organize your new power plant," by C D Swift, which found its way between hard covers as *Steam Power Plants*. The "Nuclear energy study course" is now available as *Nuclear Power Engineering*, by Schwenk, Shannon and Skrotzki. Our current "Thermo refresher" series is also slated for a hard-cover future.

A new series, modest in length and not being groomed for rebirth in book form, will bow in as part of the April issue. Dealing in fair depth with the many problems designers and operators face in living with forced-circulation lubricating systems, the new series should prove of interest to a broad group of energy-systems engineers. After a general overall consideration in the first article, authors Booser and Smeaton of General Electric will probe the intricacies of reservoirs, piping, coolers, pumps, filters and controls.

Next month will also mark the 26th "Today's Development" report we've published. The first appeared in January 1958. Following the lead of the initial report on electronic computers, each *TD* explored a part of the energy-systems field where technical advances were coming fast. Each rounded up and evaluated current ideas and developments that held promise of influencing tomorrow's practice.

This upcoming *TD* will present latest thinking on control-room design, define the trends shaping up, take a hard look ahead. Utility designers and consultants should watch for it.

Lou Lowley

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In Power this month

MARCH 1961 • VOL. 105 • NO. 3 • 79TH YEAR

Foreword: Electrical safety—Who is responsible? 55

DESIGN AND EQUIPMENT APPLICATION

Protect your motors with temperature-sensing devices 59
How to build up complete supervisory control for your plant 64
Piston-diaphragm pumps cut metering headaches 68
"Point-system" calculates pipe friction losses, streamlines size estimating 70
Stainless-steel stack goes up in one piece 72
Economic process steam from nuclear reactors—if load factor is high 73
Swedish steam-electric plant goes from cold to full rating in one hour 76
New Irish plant burns pulverized peat 80

DEPARTMENTS

Nuclear notes: News briefs on the latest developments 86
Data sheet: Determine freezing point of heating coils, tubes and turns 88
Technical briefs: A world-wide look at progress in energy-systems engineering 92
New literature: Yours simply for mailing postage-free Reader Service card 101A
Plant equipment news: Your information center for new products and materials 112
Thermo refresher: Heaters raise cycle efficiency 129
Marmaduke Surfaceblow tangles with some penny pinchers 138
Powerscope: A selective look at this month's power-field happenings 152
Calendar 164 *Appointments* 172 *Bookshelf* 178

PLANT MAINTENANCE AND MANAGEMENT

Electrical safety: Are problems mounting?—a *TD* report 183
Operators' notebook: Tiny magnetic plug protects against wear 188
The high cost of low air pressure may be eating into your budget 190
How Rohr Aircraft Corporation cuts downtime to the bone 193
Plant electrical fact file: Tips on care of apparatus bushings 196
Plant problems: Here's how Power readers tackle them 198
Practical ideas to keep your plant running at peak efficiency 202

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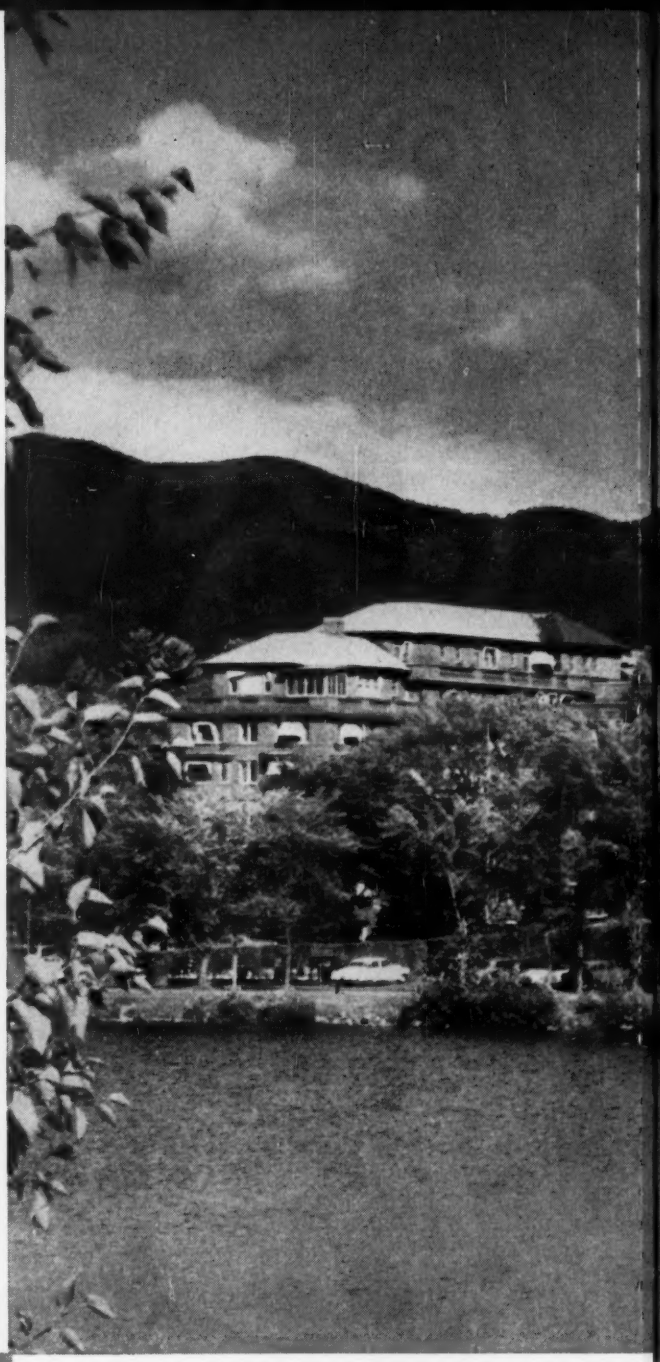
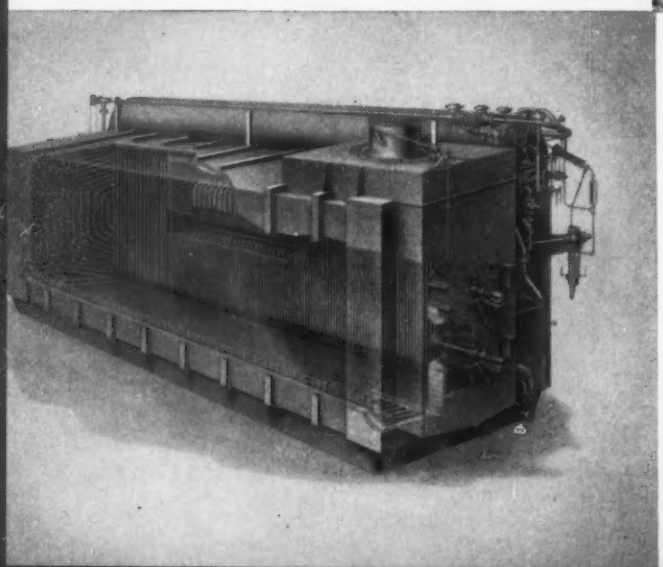
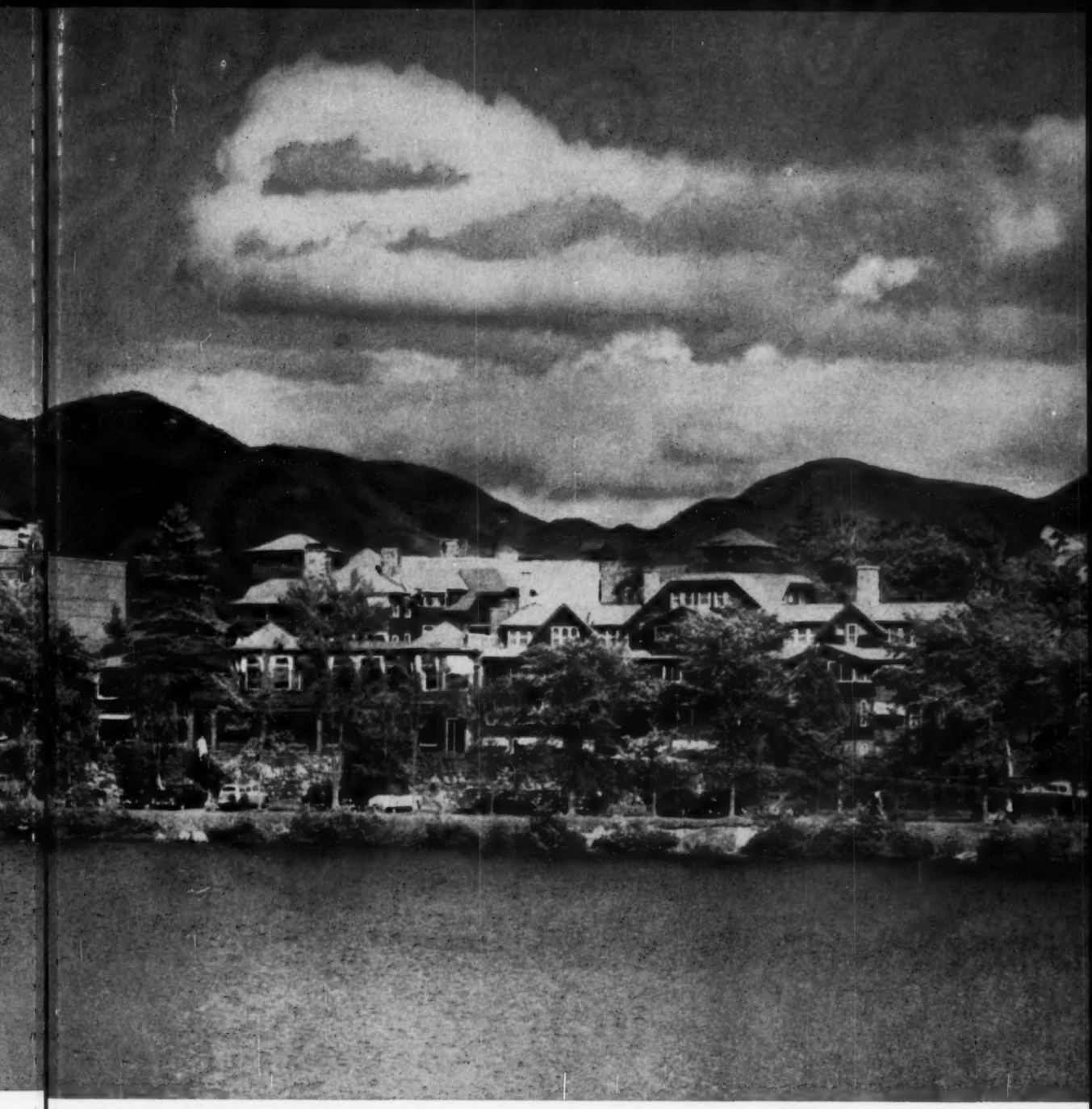




Renowned winter resort generates own steam for heating, electric power and laundry . . . finds surest answer in dependable B&W Package Boiler.

At the Adirondacks' famous Lake Placid Club, steam plays a vital role in maintaining an atmosphere of relaxation and comfort for members' and guests' enjoyment. The Club's appealing air of seclusion is won in part by privacy of location . . . so that vital heat, electricity and laundry-steam must come entirely from the Club's own facilities. The Club can also supply power in emergencies to the local hospital and fire department . . . so boiler dependability and ease of operation are critical factors in meeting these crucial and expanding steam requirements. That's why the Club followed the recommendation of Pope and Evans—consulting engineers, and added a B&W Package Boiler. With a steam



capacity of 30,000 lb per hr at an operating pressure of 250 psi with superheat to 450 F, this automatically fired unit will give efficient, economical service over a wide load range. And the Club knows that at any time in the life of the boiler—10, 20 or 30 years from now—B&W's nationwide service organization will be promptly and economically available if needed.

Providing these vital steam services for a rambling Adirondack year 'round vacation Club is further evidence-in-action of dependable steam generation by B&W. Whatever the steam requirement . . . whatever fuel is most economical . . . B&W can fill the bill. Your local B&W representative has all the fuel facts on *your* area. Call him soon. The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

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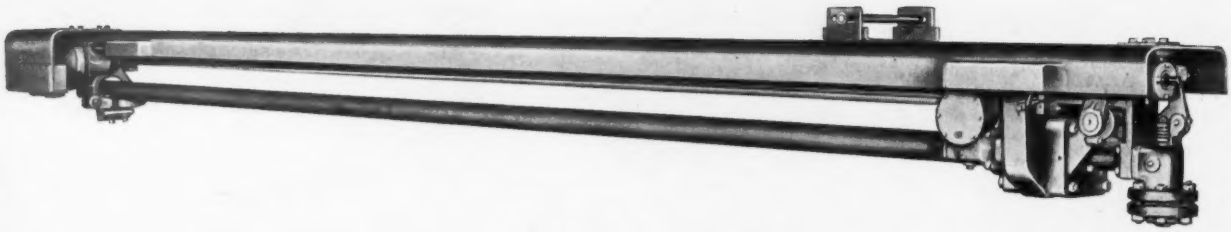

Diamond developed for more economical power...

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Lower fuel costs . . . reduced boiler outage . . . minimum manual cleaning . . . inhibited tube corrosion—these are dramatic savings achieved by Diamond Chemical Slurry Spraying Systems, a revolutionary method of controlling and removing tube deposits generated by burning oils high in vanadium, sodium and sulphur content.

Service tested on some 40 installations, Diamond Slurry Spraying offers a distinct economic advantage over fuel additives because it treats only that ash which collects on the tubes. Magnesium oxide-based slurry is sprayed on heating surfaces by conventional soot blowers modified to discharge, in alternate cycles, both the normal cleaning medium and slurry. The chemical slurry coating changes chemical composition of deposit so that it's easily removed by normal blowing.

If you burn — or are considering burning low-grade oil, it will pay you to take a close look at Chemical Slurry Spraying . . . another Diamond-Developed Boiler Cleaning System. At your request, our engineers will make recommendations based on your specific requirements. Call, write or wire for complete information.

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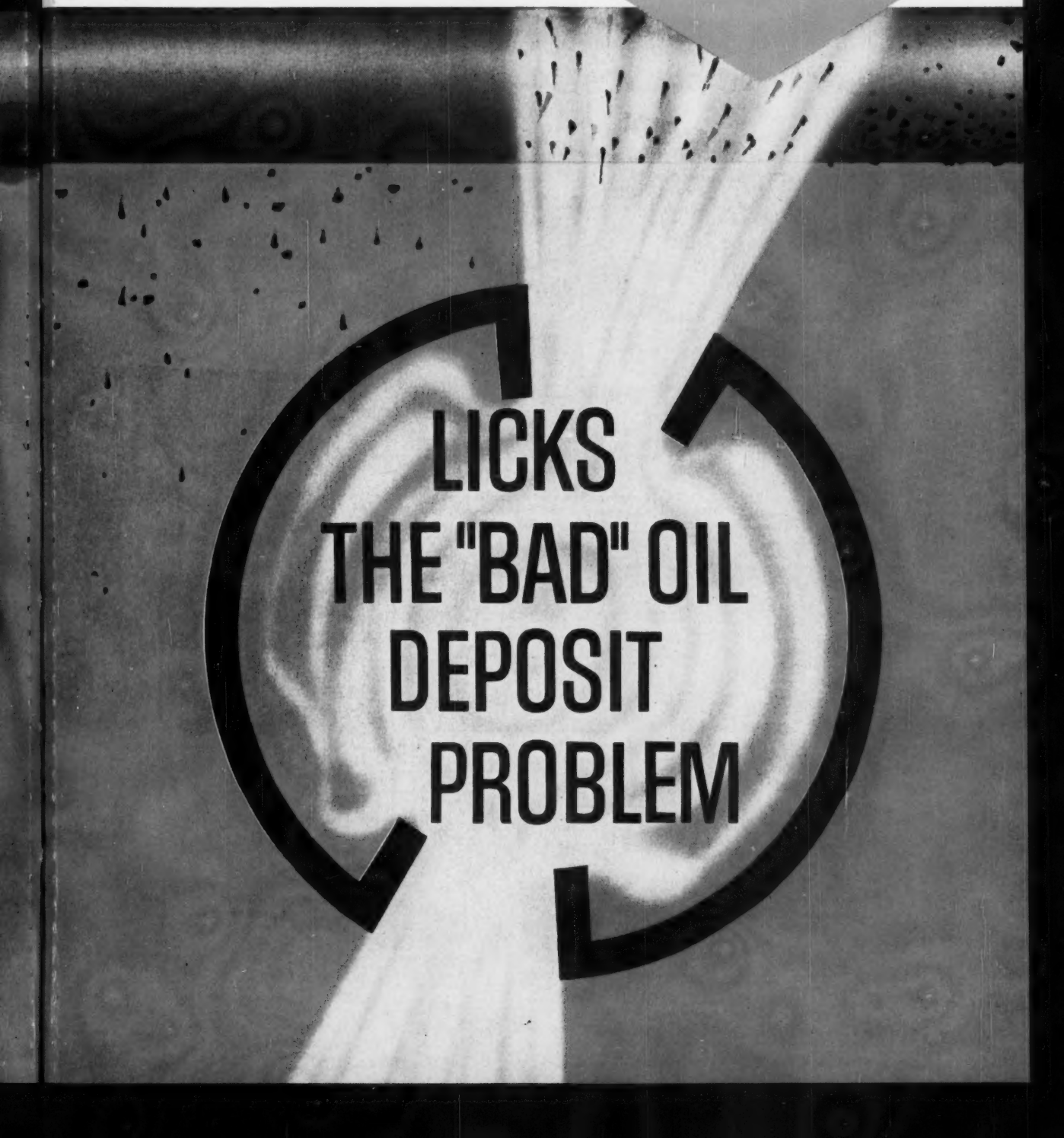

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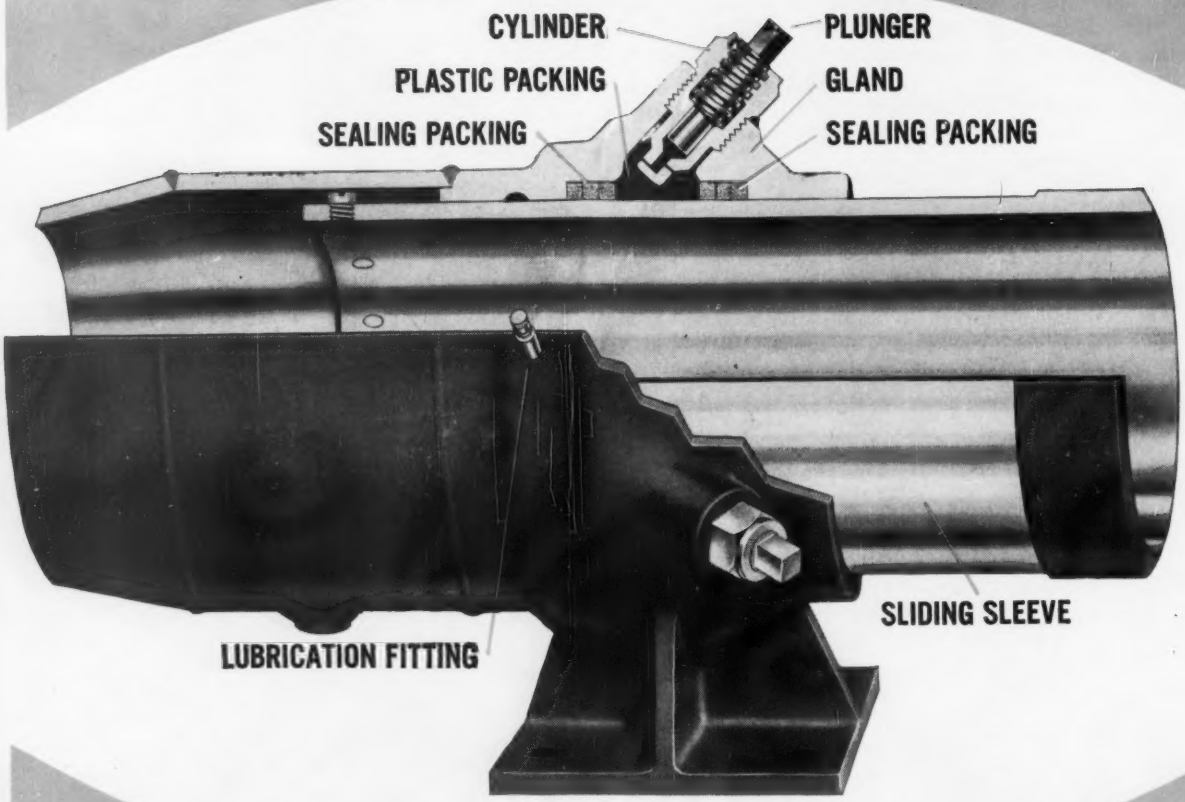
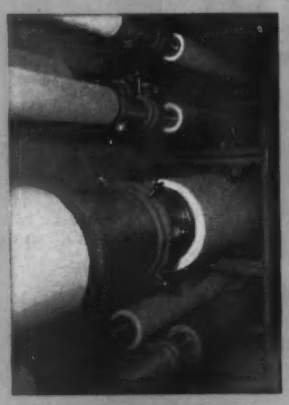
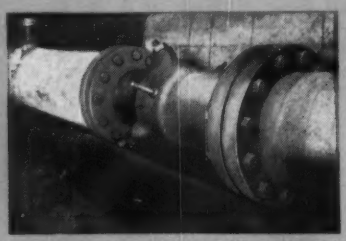


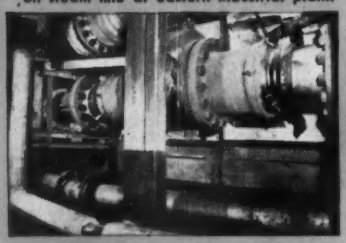
Only Yarway GUN-PAKT combines these outstanding features with design simplicity. GUN-PAKT Joints are available in single or double ends, welding or flanged, and in standard pipe sizes up to 30".



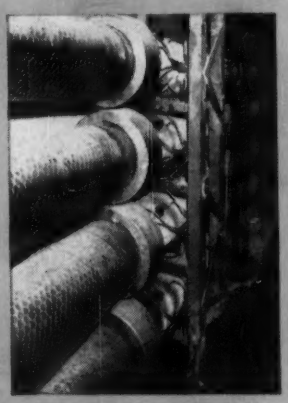
5 of 36 Yarway Gun-Pakt Joints, 2½" to 16" sizes, welding ends on steam lines at mid-west state institution.



6" Yarway Gun-Pakt Joint, flanged ends, on steam line at eastern industrial plant.



Two 10" Yarway Gun-Pakt Joints, flanged ends, on return line of high temperature water system at New Jersey industrial plant.



Group of 8" Yarway Gun-Pakt Joints, with automatic lubrication, on high temperature water lines at large international airport.

WATER LINES THESE BENEFITS...

- ✓ *TROUBLE-FREE SERVICE*
- ✓ *LOW MAINTENANCE*
- ✓ *SIMPLIFIED DESIGN*

WITH YARWAY GUN-PAKT EXPANSION JOINTS

Only Yarway GUN-PAKT Expansion Joints offer *simplicity*, *efficiency*, and *freedom from the "headaches"* that plague many plant engineers. That's why more engineers are specifying Yarway for efficient operation of steam and high temperature water piping in industrial plants, institutions and universities.

Yarway GUN-PAKT Expansion Joints offer you these advantages:

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RUGGED DEPENDABILITY — All-steel construction with durable, chromium-plated, seamless steel sleeves. No chance of *metal fatigue.* Wrought steel bases provide rugged, positive anchorage.

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LIGHT WEIGHT, STREAMLINED DESIGN—Requires less space to install, less space to maintain, smaller manholes, fewer joints needed per length of pipeline.

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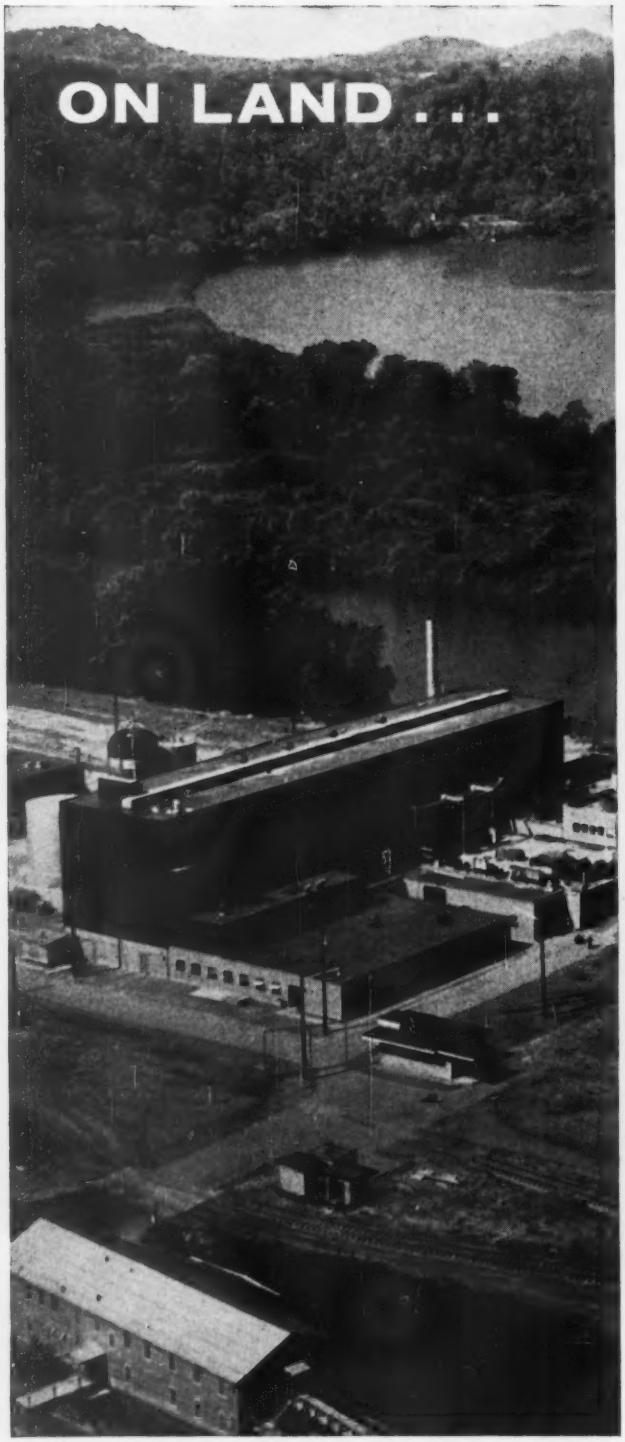

At the Shippingport Station, world's first full-scale atomic, electric power plant devoted exclusively to civilian use, Bailey instruments and controls help to secure full capacity and safety.

Typical of the modern U.S.-Flag tanker fleet using Bailey controls is the ESSO Gettysburg. You'll also find Bailey controls aboard Naval ships, cargo ships and lake steamers.

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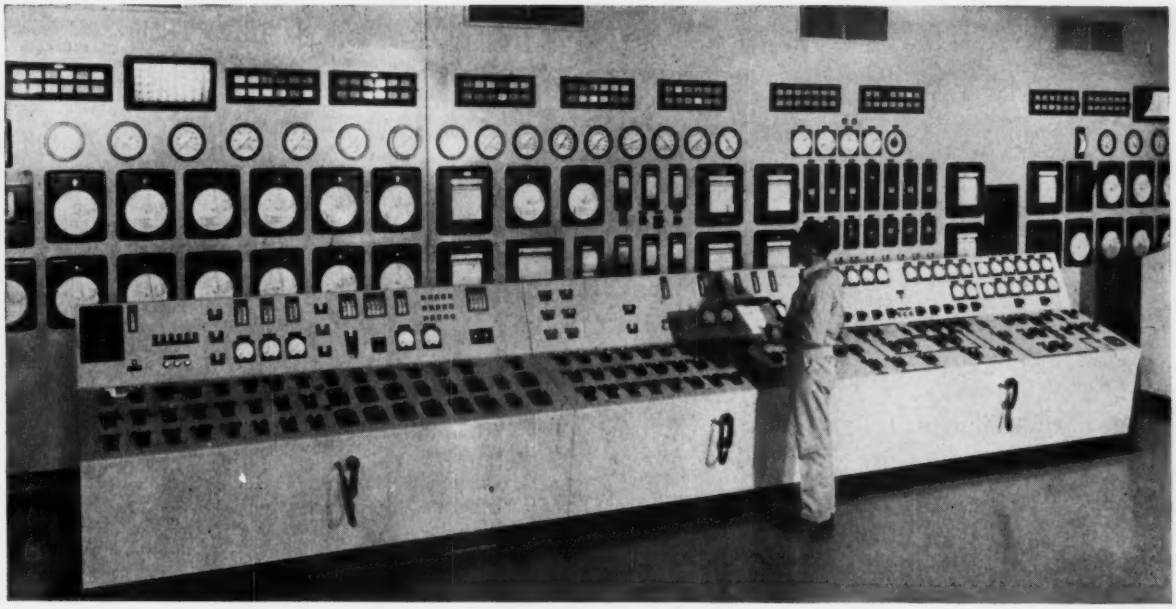

for the latest and safest instruments and controls for nuclear and conventional power plants!

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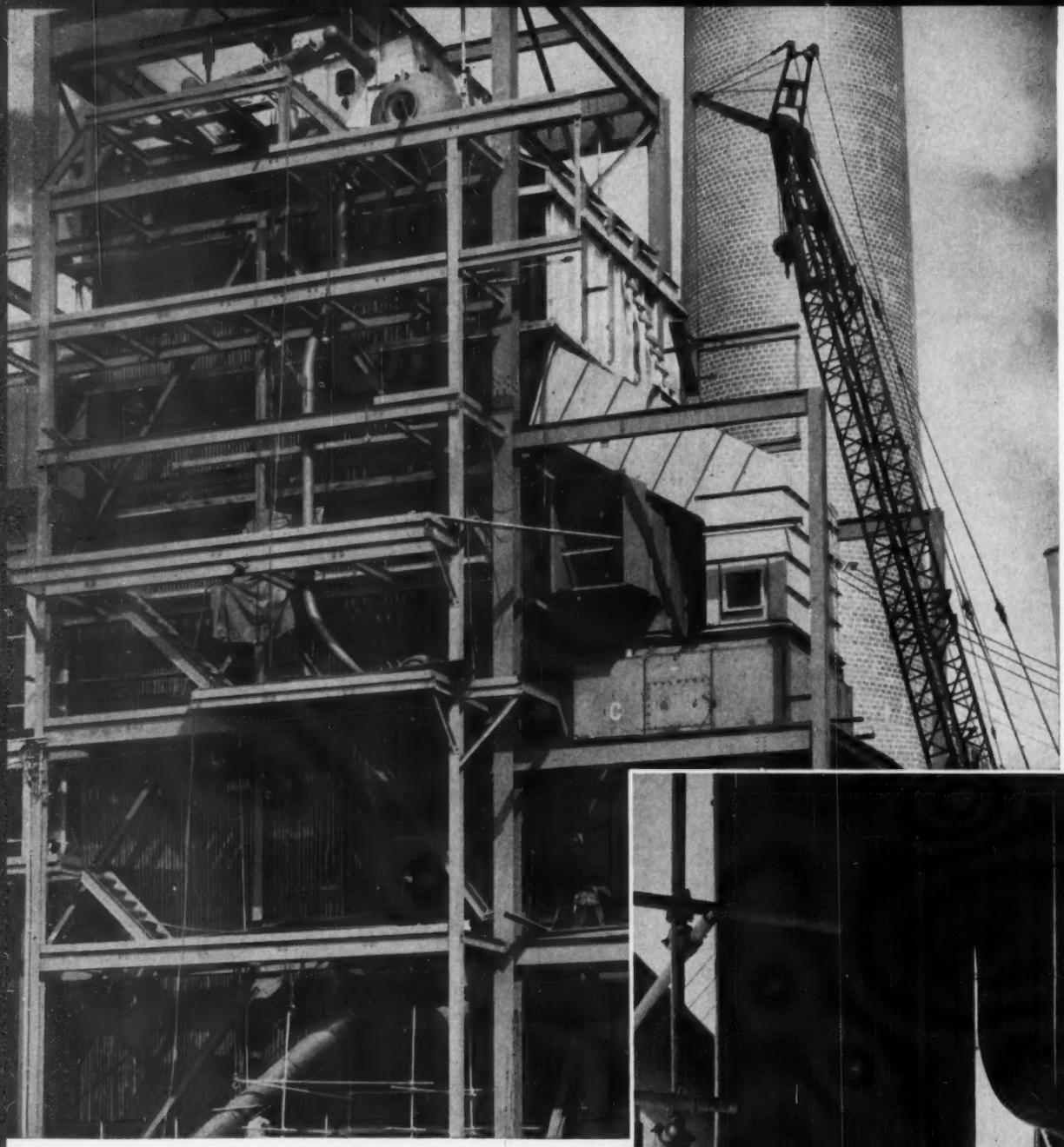
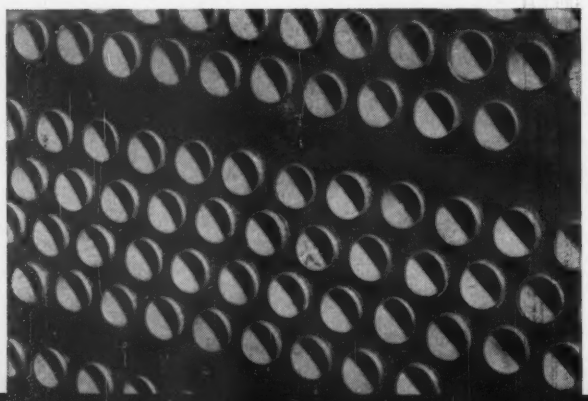


REPUBLIC ELECTRUNITE STAINLESS STEEL HEAT EXCHANGER TUBING resists corrosion and provides long trouble-free service for main surface condensers in utility power plants where water is used directly from natural sources. Call your Republic representative for additional information, or send coupon.



REPUBLIC ELECTRUNITE BOILER TUBES reduce installation time and operating costs because quality is built-in. Full normalizing, uniform wall thickness, and true concentricity assure easy workability and in service dependability. Bends are smooth and uniform. Rolling-in operations easier. The Riley RX Unit, above, is an addition to the Tallahassee municipal power plant at St. Marks, Florida.

Tallahassee "powers up" with

REPUBLIC ELECTRUNITE BOILER TUBES

When more power was needed to meet the growing needs of growing Tallahassee, the city authorized Riley Stoker Corporation to design, engineer and erect a new RX Boiler unit.

Riley tubed both boiler and water walls of this new unit with Republic ELECTRUNITE in 2½" and 3¼" sizes. With the ELECTRUNITE Tubes rolled-in, the Riley RX operates at a continuous unit capacity of 220,000 lbs. of steam per hour, with an operating pressure of 1050 psi, at 950°F.

You can trust Republic ELECTRUNITE Boiler Tubes always to roll-in easily. Because, the ELECTRUNITE process assures true tube concentricity, uniform ductility, freedom from hard spots. Uniform wall thickness and diameter, too. Bends are smooth, wrinkle-free, uniform. You never tubed it so good!

This quality tube is produced to meet ASTM specifications, ASME Boiler and Pressure Vessel Code, Federal and State committees, and boiler insurance requirements.

Power up your equipment with the one tube everybody trusts . . . for performance, dependability, and initial economy. Contact your Republic representative, or return coupon below for facts.

FARROWTEST REJECT TABLE

Wall Thickness (B.W. Gage)	Minor dimension of the defect (Length or Depth)	Defective Area (Length, Depth Plane)
20	.006"	.0025 sq. inches
18	.006"	.003 sq. inches
16	12½% of wall	.003 sq. inches
14 and 13	12½% of wall	.004 sq. inches
12 and heavier	12½% of wall	.005 sq. inches

FARROWTEST detects and rejects not only tubing containing defects which completely penetrate the wall; but also tubing with defects equal to, or greater than, those shown in this table. For irregular defect shapes, a tube with defect area equal to or greater than shown above is rejectable. Where required, sensitivity of FARROWTEST equipment can be calibrated to reject defects of lesser specified area than shown in table, at extra cost.

FARROWTEST—QUALITY YOU CAN MEASURE. Not a mere laboratory theory, not a mere inspection tool, but an exclusive eddy-current production line test that detects and rejects tubing containing defects of critical size. FARROWTEST is offered as an alternative to other less positive tests in accordance with the table above, at no extra cost.

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Steel — Strong, Modern, Dependable

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DEPT. PO-1681
1441 REPUBLIC BUILDING • CLEVELAND 1, OHIO

Please send more information on the following products:
☐ Republic ELECTRUNITE® Boiler Tubes ☐ FARROWTEST®
☐ ELECTRUNITE Stainless Steel Heat Exchanger Tubing

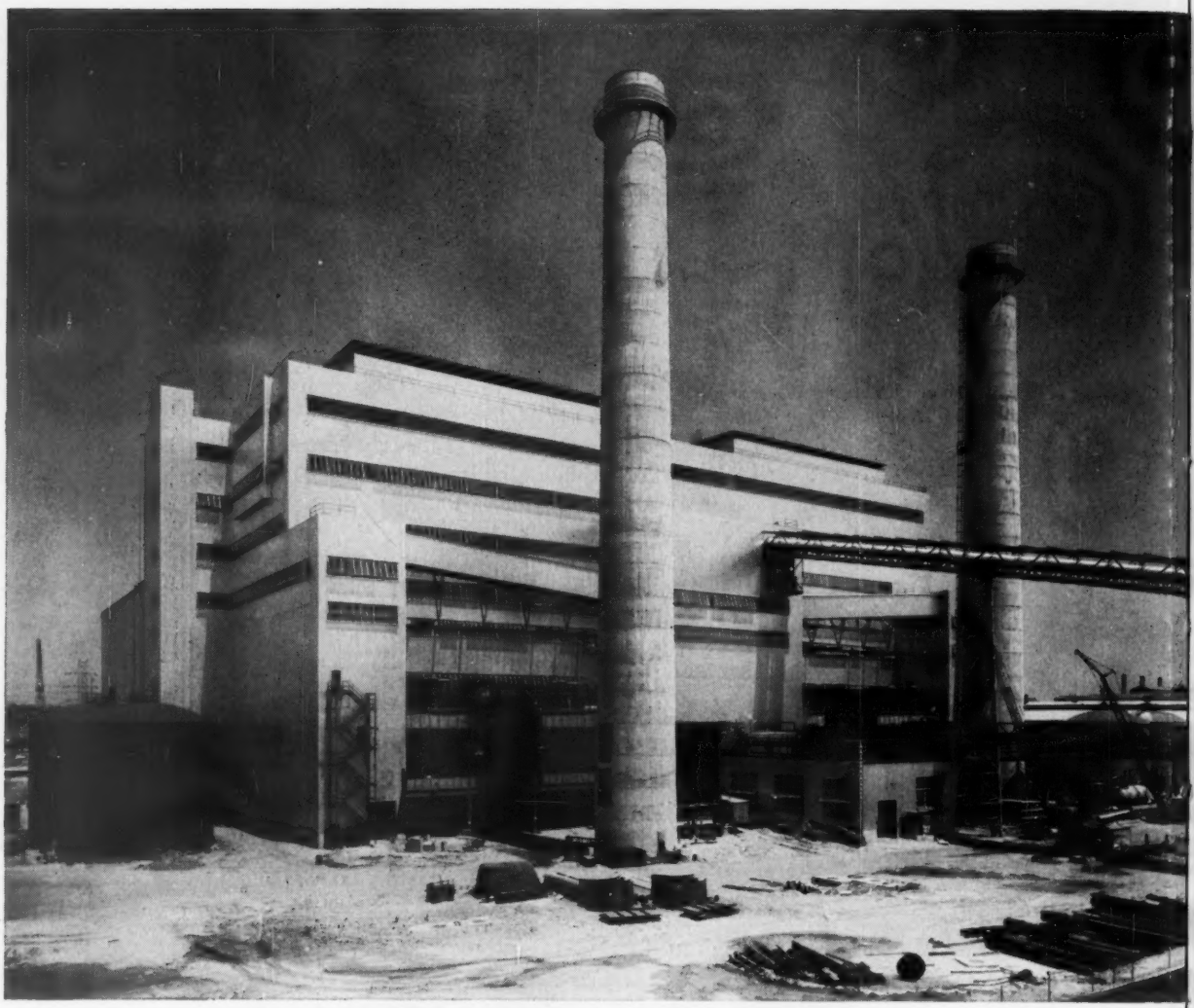
Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____

For more facts circle 209 on Reader Service card, p 101



Eddystone Station's Unit 1 has a capacity of 2,000,000 lb/hr at 5000 psig, and 1200°/1050°/1050°/F . . . uses C-E Sulzer Monotube Steam Generator.

Vulcan Selective-Sequence system provides Eddystone Station with precision soot blowing

When Unit 1 of Philadelphia Electric's Eddystone Station went into operation, a Vulcan Selective-Sequence system was accurately controlling all soot blowing.

Selective-Sequence systems were chosen for both units 1 and 2 at this super-critical station because they assure positive, dependable boiler cleaning . . . make the most efficient use of the blowing medium.

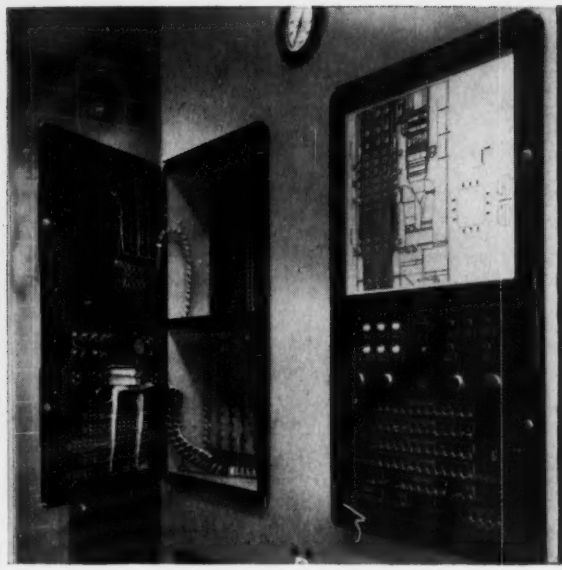
Vulcan Controller saves time. Without leaving the panel, the operator pushes a master button to place the system in sequential operation. He can see that each soot blower is operating in sequence for the proper interval with adequate pressure. He can modify the sequence to improve cleaning or conserve the blowing medium without time-consuming wiring and piping changes.

Vulcan long retractables speed cleaning. With dual-motor drive, Eddystone's T-30's minimize the danger of tube cutting or erosion. Low rotating speed increases range and penetration, decreases wear, eliminates whip, and permits cleaning with faster traversing speeds.

Half-'tracts with 19-foot travel, wall deslaggers, and air pre-heater controls are also used. For details, write Copes-Vulcan Division, Erie 4, Pa.

Copes-Vulcan Division

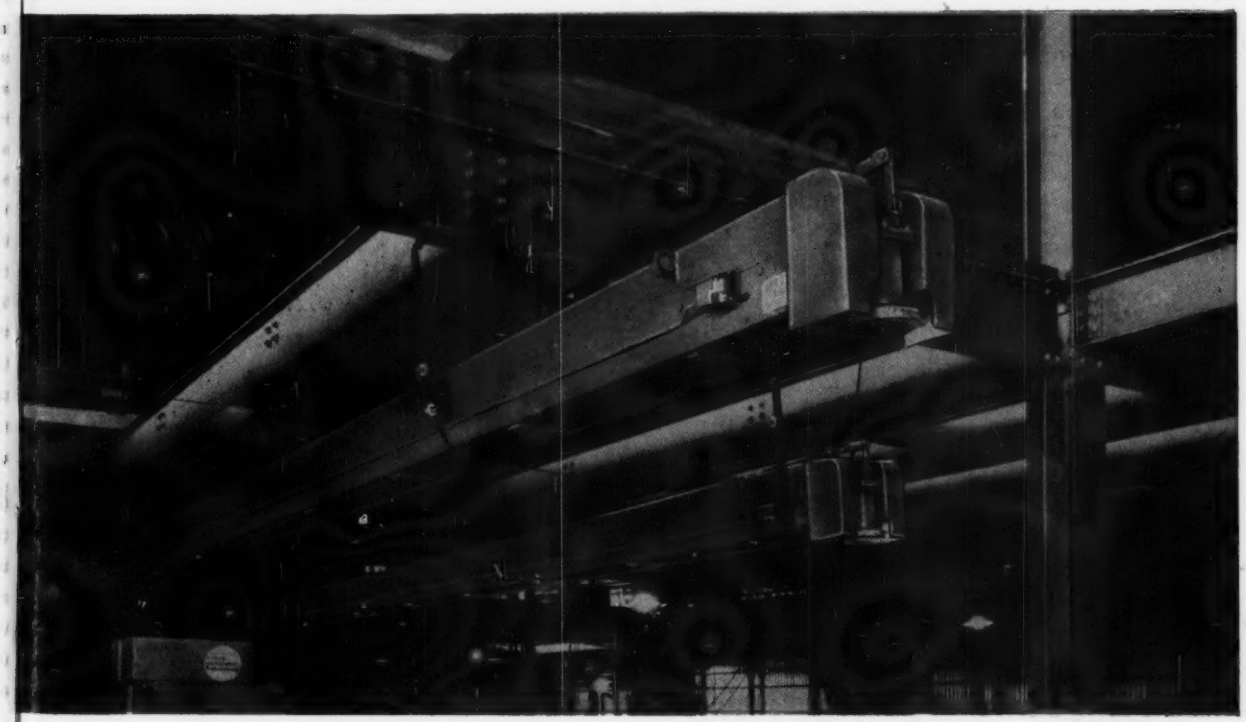
BLAW-KNOX



Panel provides centralized control of soot blowing at Eddystone. With the Vulcan SSC-120 Selective-Sequence controller, each blower can be operated four times during a schedule, or there can be four different schedules. The sequence can be varied by means of a jack board. Any soot blower can be operated at any point in the sequence by plugging one end of a patch cord into the blower jack, and the other end into the desired sequence jack. Write for Bulletin 1029.

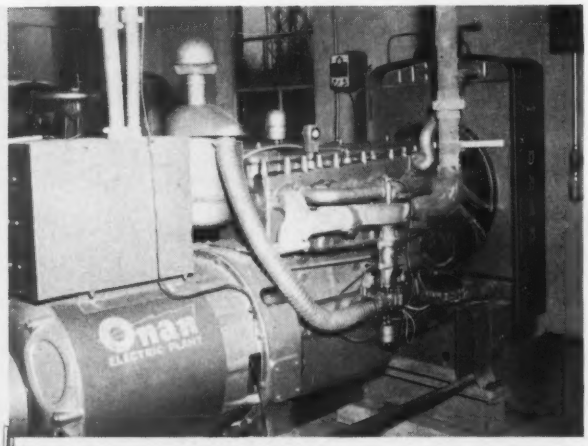
Wall deslagger conserves steam generated at Eddystone by three special package boilers. High striking power of Vulcan RW-3E drives off gummy masses to assure high heat-transfer capacity, and uniform superheat and reheat temperature control. Dual motors are used: one speeds the nozzle to and from the blowing position, the other rotates it slowly for thorough cleaning. All parts are covered for protection, assuring long life with low maintenance. Write for Bulletin 1034.

Vulcan T-30's have 30- and 37-foot travels. Motors are mounted at the boiler end to facilitate maintenance, yet away from heat of the boiler wall. Their placement avoids interferences. Write for Bulletin 1030.

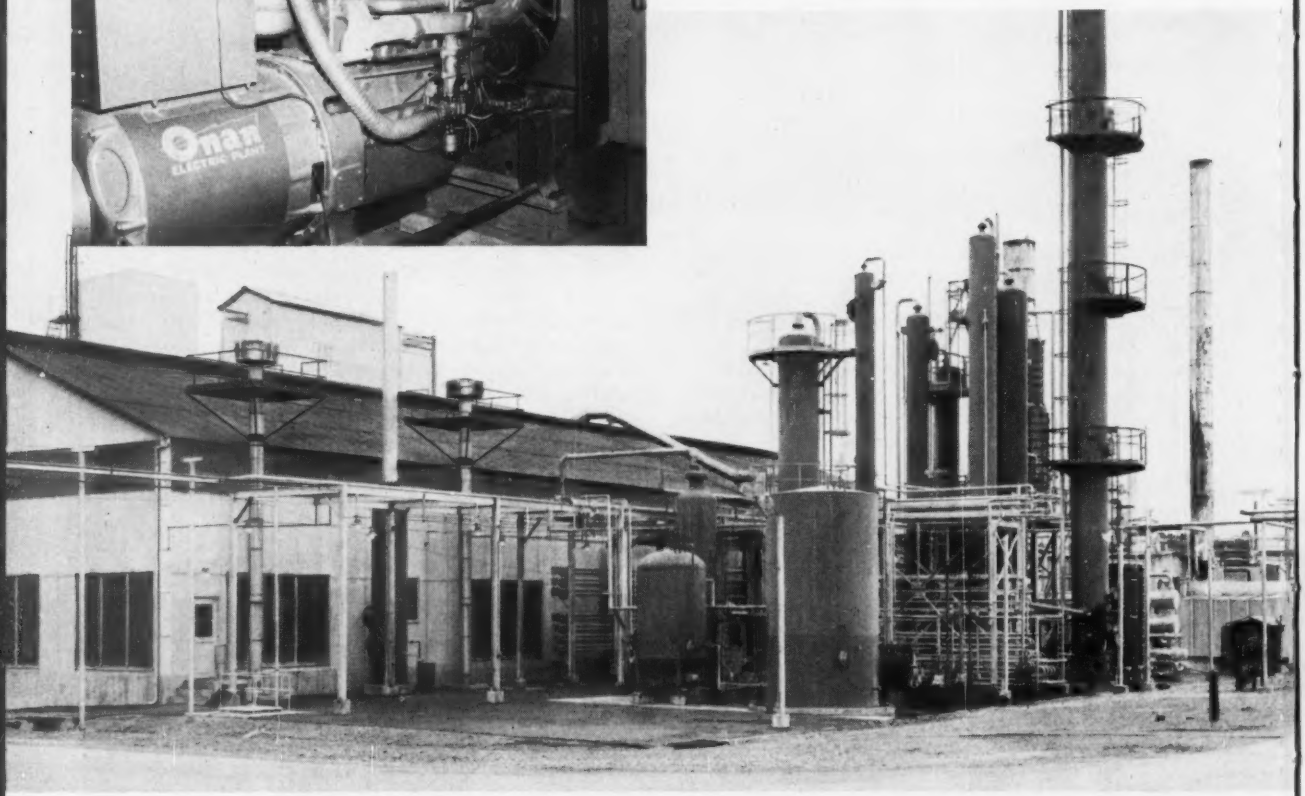


For more facts circle 210 on Reader Service card, p 101

Beefed up for hardest



For portable electric power or standby for critical process, you can't afford to gamble on auxiliary power failure. That's why Onan gives every plant the toughest possible tests before it's shipped to you. *Only* Onan is certified to deliver every watt of power the nameplate promises. Before you buy any electric plant, talk to your Onan distributor. He's in the Yellow Pages.



Stellite coated exhaust valves and valve seats. One of toughest alloys known. Gives you up to 300% longer valve life than uncoated valves. It's the important details like this that make Onan more economical in the long run.

Exacting standards govern manufacture—years of specialized experience and extensive testing facilities control the quality of Onan Power Plants. Over 1000 different types and sizes of plants are produced by Onan.

use...even abuse

Onan electric plant still delivers full power after 12,197 hour test—equal to 487,888 miles

A grueling endurance test that lasted one year, nine months and 12 days could not stop Onan test plant #1068. Onan engineers used this production-built unit for an endurance run—and after it was all over, it still generated the full rated power promised on the nameplate. Proof that Onan's exacting standards and production testing give you a power plant with long, dependable life built in.

Over 1,700 other endurance units have been run by Onan engineers. In these tests every design feature and part has to prove itself before it can become a part of the Onan you buy. In addition, every type and size Onan plant is tested under all operating conditions which could conceivably affect performance on your job.

Hours of running in and testing under full load are given *every* Onan before it is shipped. An independent testing laboratory then spot tests Onan Plants that have already been tested by Onan—double assurance that every Onan will deliver its full nameplate rating. Only then does an Onan production run qualify for Performance Certification.

Buy *proven performance* when you buy an Electric Plant. See your authorized Onan distributor or dealer. You can depend on him for a lifetime of factory parts and service. He's listed in the Yellow Pages.

ONLY ONAN GIVES YOU THIS CERTIFICATION

Onan
Onan
PERFORMANCE CERTIFIED
We certify that when properly installed and operated this Onan electric plant will deliver the full power and the voltage and frequency regulation promised by its nameplate and published specifications. This plant has undergone several hours of running-in and testing under realistic load conditions, in accordance with procedures certified by an independent testing laboratory.

World's Leading Builder of Electric Power Plants

ONAN DIVISION, STUDEBAKER-PACKARD CORPORATION • 2675 UNIVERSITY AVE. S. E., MINNEAPOLIS 14, MINNESOTA

For more facts circle 211 on Reader Service card, p 101

New Soft-Seat Design...

The soft-seat design provides tight shut-off through the normal flow path and a seal to prevent leakage through the threaded parts. The insert is fully retained in closed position, and is held with sufficient force to prevent blowout even at differential pressures in excess of 1000 psi. The insert is protected by metal-to-metal backup.

Soft-seat plugs are available in nominal sizes from 1″ to 10″. Inserts may be of Buna-N, Teflon or Glass Filled Teflon.

These materials are long lasting under conditions for which they are designed. Inserts may be replaced and materials are interchangeable.

20000 Series Valves may be converted to soft-seat trim in the field by installing plug and ring sets.

NOW!

The Advantages of 20000 Series Valves plus

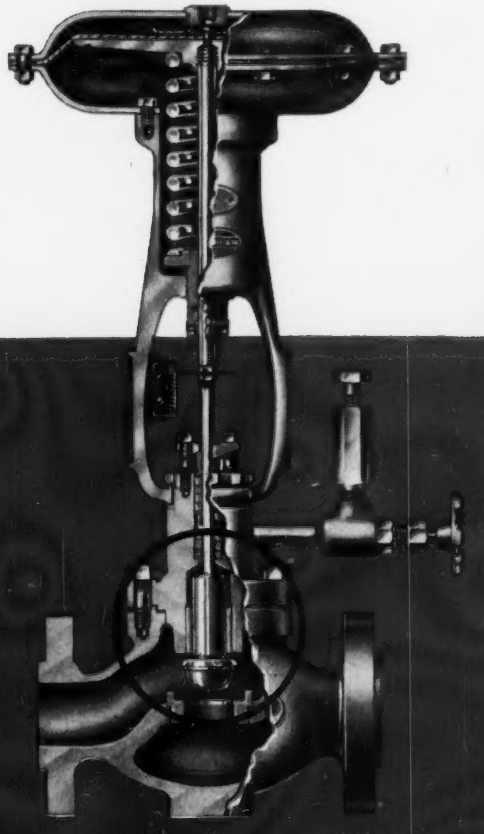
TIGHT SHUTOFF

without Sacrificing Capacity or Characteristics

Now you can have high-capacity single-seated control valves with soft-seat tightness — without sacrifice of percentage characteristics. This design, moreover, permits static pressures and pressure drops up to 500 psi.

Soft-seat inserts of several materials are available to meet varying conditions. For example: *Buna-N* for temperatures to 200 F; *Teflon* for temperatures to 300 F and resistance to chemicals; *Glass Filled Teflon* for temperatures to 500 F, for high-mechanical strength, corrosion resistance and for steam service. Metals available are identical with those normally used in metal-to-metal seating.

This new trim is a logical extension of the versatility inherent in the 20000 Series, designed to meet the growing preference for single-seated control valves. If you do not yet have information on the most versatile control valves available, ask a Mason-Neilan representative or write —



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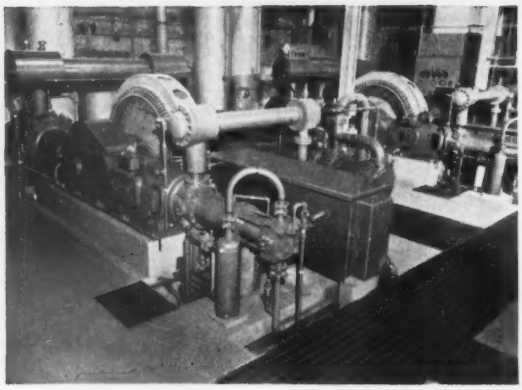
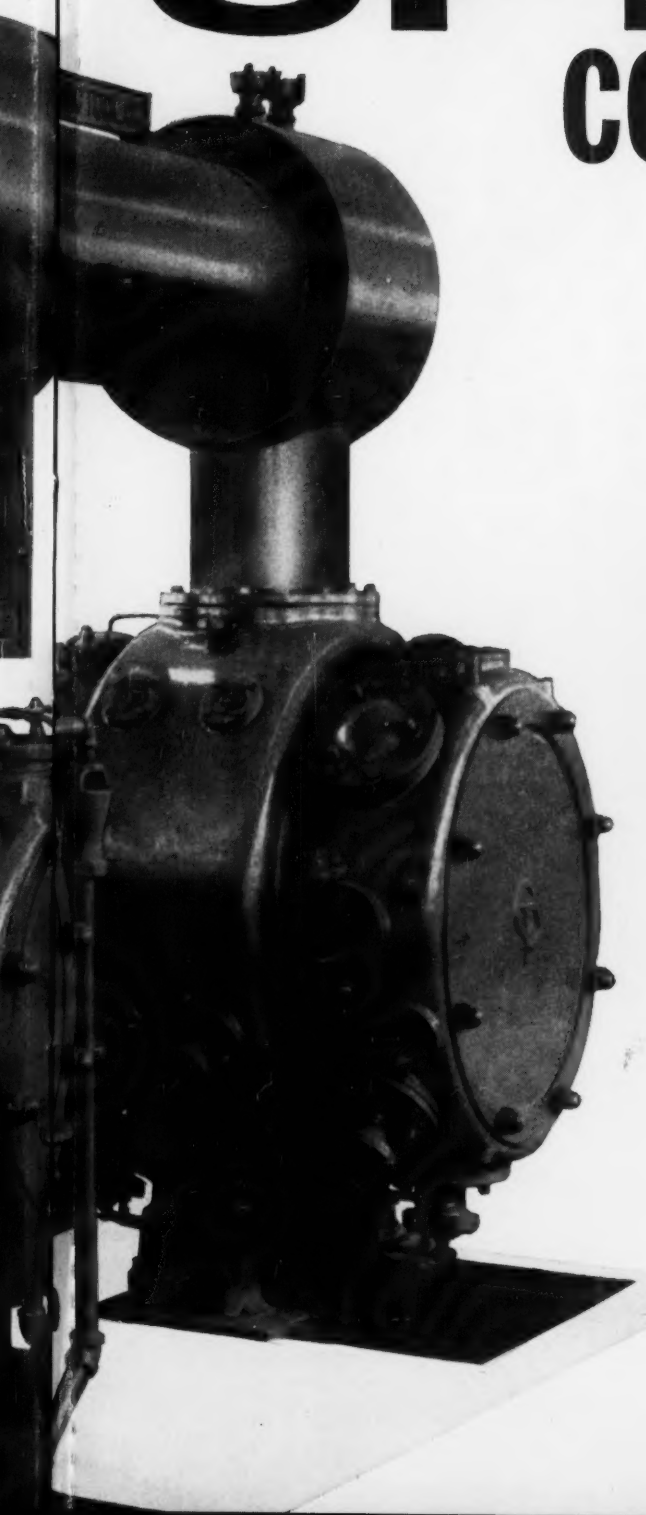
HORIZONTAD



Class H-CE, 4-corner, 5-stage compressor
operating at 3,000 psig

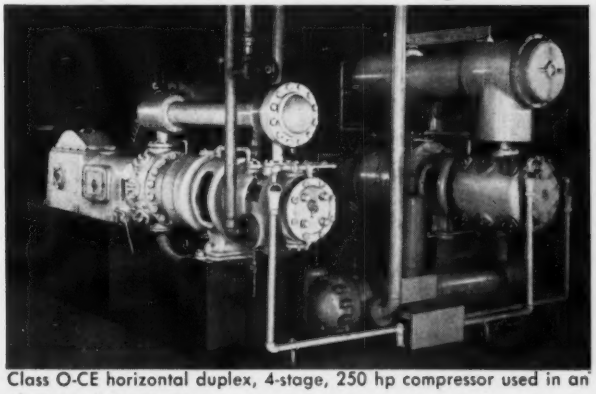
A battery of these 800 hp Class O-CE Compressors serve a large steel mill



LOW SPEED COMPRESSORS

Chicago Pneumatic offers a wide variety of designs of compressors in sizes up to 5,000 horsepower and for pressures up to 15,000 psig.

Horizontal machines such as the Class O Duplex and the Class H Horizontal Four-corner Compressor are preferred for many applications because of their low speeds, greater accessibility, greater flexibility of cylinder arrangements for many multi-stage installations, and for lower maintenance cost, and longer life.



Class O-CE horizontal duplex, 4-stage, 250 hp compressor used in an air separation process

Chicago Pneumatic

AIR AND GAS COMPRESSORS • VACUUM PUMPS • PNEUMATIC AND ELECTRIC TOOLS • DIESEL ENGINES • ROCK DRILLS • HYDRAULIC TOOLS

SEND THIS COUPON . . . Get Your Free Copy of "Compressor Specifications" Now!

Includes 14 pages of compressor engineering data, plus 2 special reports on reciprocating compressors.

Chicago Pneumatic Tool Company **Dept. P-11**
8 East 44th Street, New York 17, N. Y.

Please send FREE copy of "Compressor Specifications" to:

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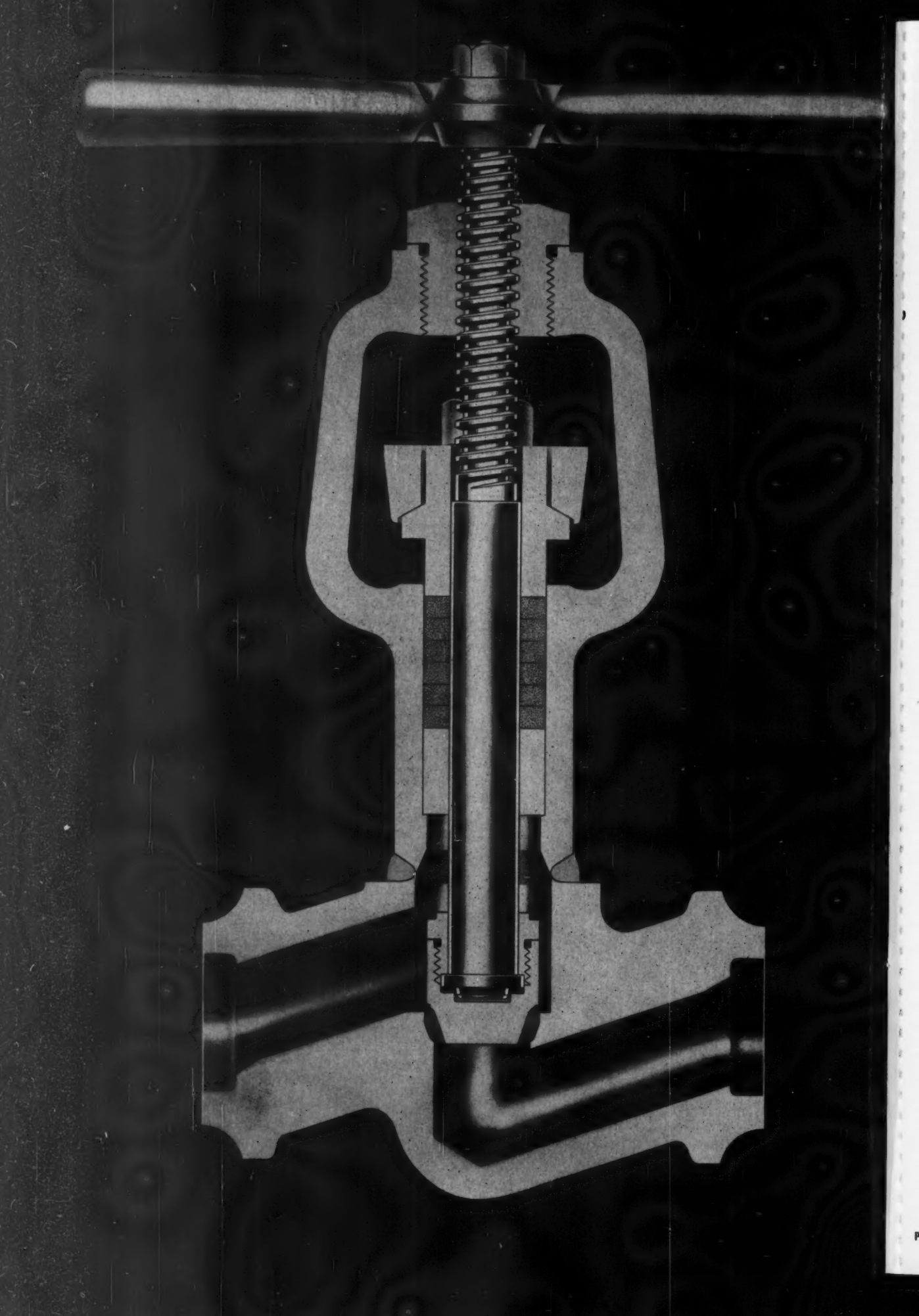
For more facts circle 213 on Reader Service card, p 101



Valves of quality always let you schedule boiler outages

A valve usually receives serious thought only when BTU losses become substantial and service to customers is endangered . . .

Hancock Steel Valves are the product of leadership in matching boiler and power piping requirements. They set the standard for leakproof valve performance in public utility and industrial power service with designs and materials for conventional, supercritical, and nuclear fueled plants. Each type of valve has that extra measure of quality that keeps modern power generating and all high-pressure process facilities on the line . . . quality that wards off maintenance even under the severest conditions of application.

The valve illustrated at the left is the Hancock Type 7130 Steel Globe Valve widely used by the power and process industries.

For technical assistance in selecting quality Hancock Steel Valves, phone your industrial supply distributor or write for Catalog 200A.

MAXWELL MANNING M&M & MOORE INC. TRADE MARK

HANCOCK Steel Valves

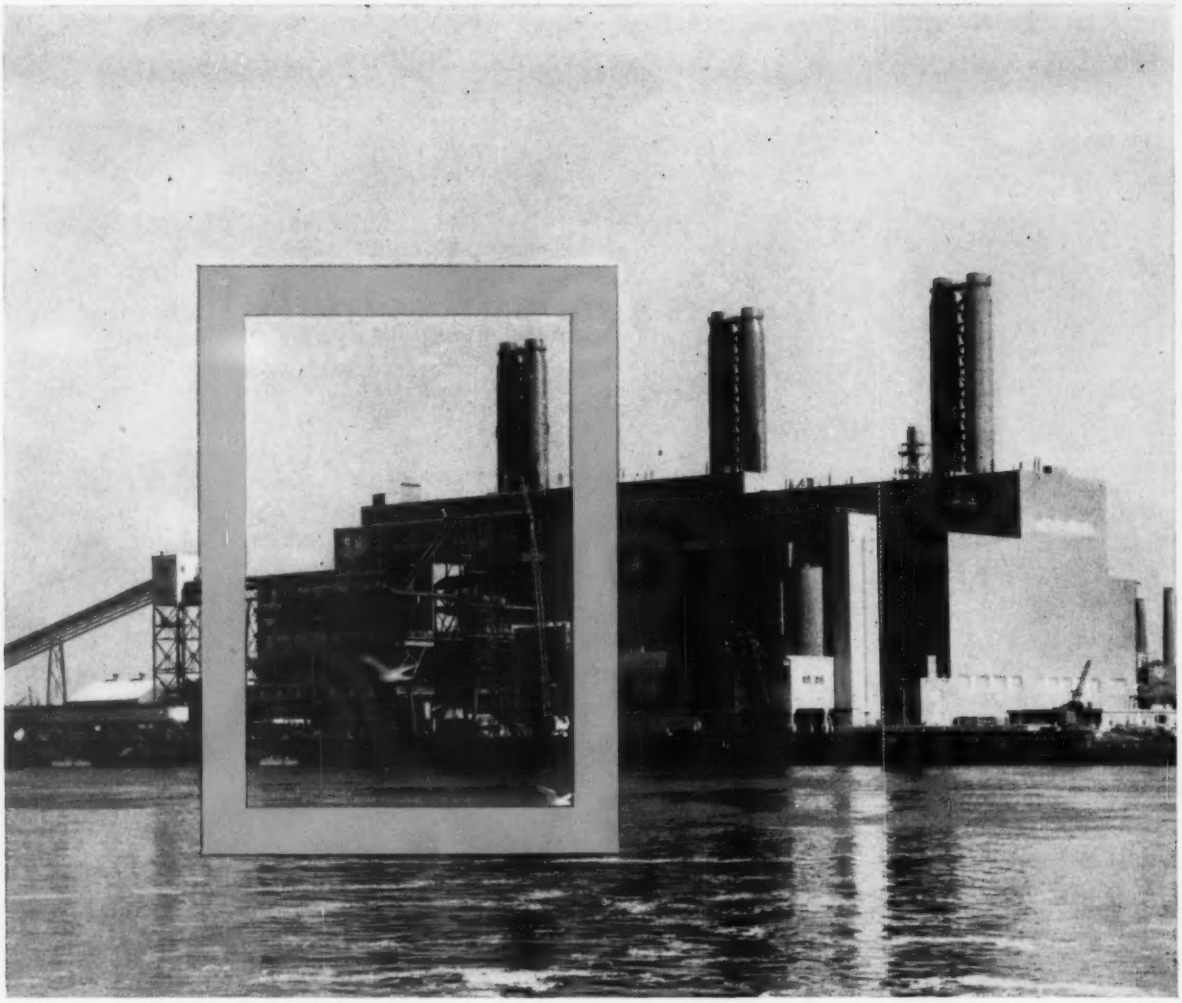
A product of

MANNING, MAXWELL & MOORE, INC.

Valve Division, Watertown, Massachusetts

Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario
Latin America: Export Division, Chrysler Building, New York, N. Y.
Europe: Manning, Maxwell & Moore, S.A., Fribourg, Switzerland

For more facts circle 214 on Reader Service card, p 101



At Consolidated Edison's Astoria Station Unit No. 4 . . .

NEW PHELPS DODGE TECHNIQUE

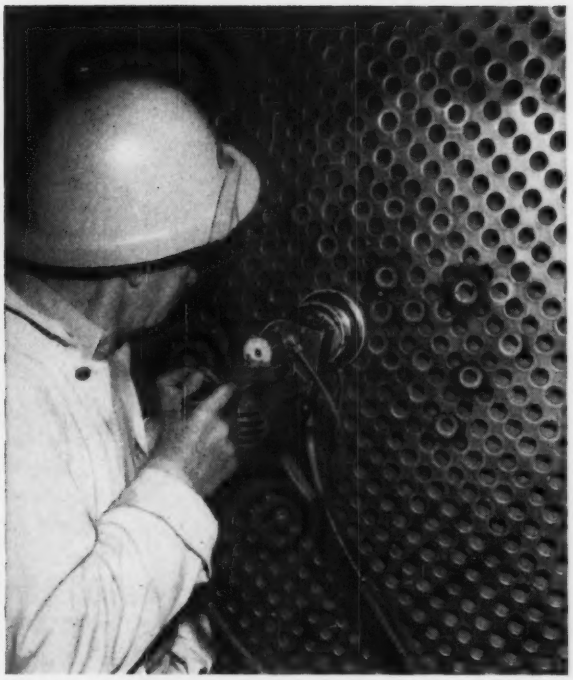
WELDS-IN ALUMINUM BRASS CONDENSER TUBES!

The first welded main condenser using aluminum-brass condenser tubes has recently been completed at Consolidated Edison's Astoria Station. This condenser will help to add a 357,000 KW block of generating capacity to the line in 1960. Half of these tubes were manufactured by Phelps Dodge under rigid specification. All of the tubes were welded in by the M. H. Treadwell Company under Phelps Dodge supervision. In tests to date, the welded condenser tube joints have surpassed performance predicted for them.

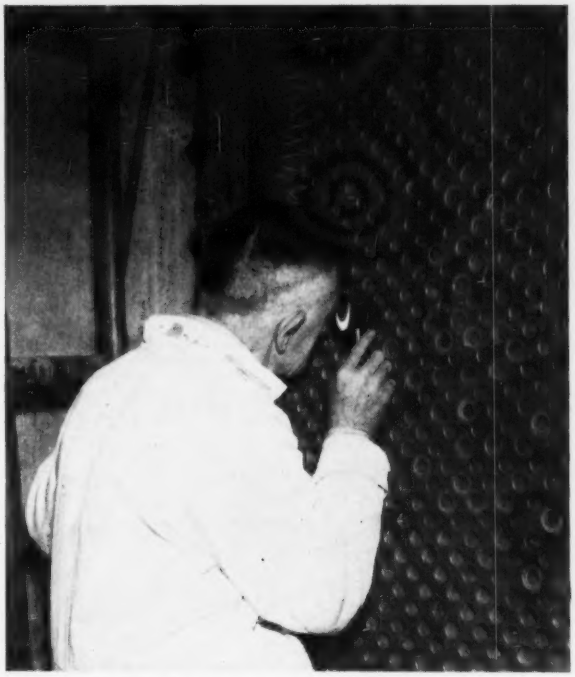
Specially designed Phelps Dodge welding guns which automatically weld tubes to tube sheets were used by Treadwell. The entire operating cycle for these guns is controlled by preset relays and timers. These relays and timers start, stop and regulate electrode motion, welding current and argon flow.

This new technique, pioneered in Phelps Dodge laboratories, answers an industry need for more positive, permanent protection from tube joint leakage. It is another in the long list of significant contributions Phelps Dodge has made in the heat exchanger and condenser tube field during more than 40 years of outstanding service.

In first step, tubes are installed in the main condenser and flared prior to welding operation. Careful attention is paid to keeping tube joints clean at all times.



Tubes are welded securely to tube sheet with special type gun. Average operator makes a completely tight weld in less than thirty seconds for each tube.



Individual tube welds are carefully inspected with magnifying glass. Incomplete or unsound welds are corrected by re-welding.

Additional inspection test consists of painting soap bubble solution on tube sheet. When main condenser is placed under 5 psi air pressure, leaks are readily detected.

PHELPS DODGE COPPER PRODUCTS
CORPORATION
300 Park Avenue, New York 22, N. Y.

PD

For more facts circle 215 on Reader Service card, p 101

Armstrong announces Armaflex 22 —a new, improved pipe insulation

An improved flexible foamed plastic pipe covering, with a broader temperature range and a super-smooth surface finish, has been developed by Armstrong.

This easy-to-apply insulation can be used on hot lines operating up to 220° F., as well as on all cold piping at temperatures down to zero and below. The new, smooth surface gives every installation a neatly finished look.

In addition to being an efficient insulator, Armaflex 22 has high resistance to water and vapor penetration, is self-extinguishing, ozone resistant, and has negligible odor.

Armaflex 22 is made in 6-ft. lengths, in ⅜", ½", and ¾" wall thicknesses for pipe and tubing from ⅜" to 3⅛" i.d.

For free booklet on Armaflex 22, write Armstrong Cork Company, 2203 Riggs Ave., Lancaster, Pa.

COMPARISON CHART

Here's how the physical properties of Armaflex 22 compare with other flexible foamed plastic pipe coverings.

Physical Properties	Armaflex 22	Brand A	Brand B	Brand C	Brand D
Low Density less than 7.5 lb./cu. ft.	Yes	No	Yes	Yes	Yes
Low Water Vapor Transmission less than .15 perm	Yes	No	No	Yes	No
Low Water Absorption less than 3% by volume — 28 days	Yes	No	No	Yes	Yes
Dimensionally Stable at 220° less than 5% lineal shrinkage — 28 days	Yes	No	No	No	No
Dimensionally Stable at 200° less than 5% lineal shrinkage — 28 days	Yes	Yes	Yes	No	No

Properties evaluated at Armstrong Research and Development Center

Armstrong INSULATIONS

For more facts circle 216 on Reader Service card, p 101

Controlled thrust and controlled torque valve controls for power plants

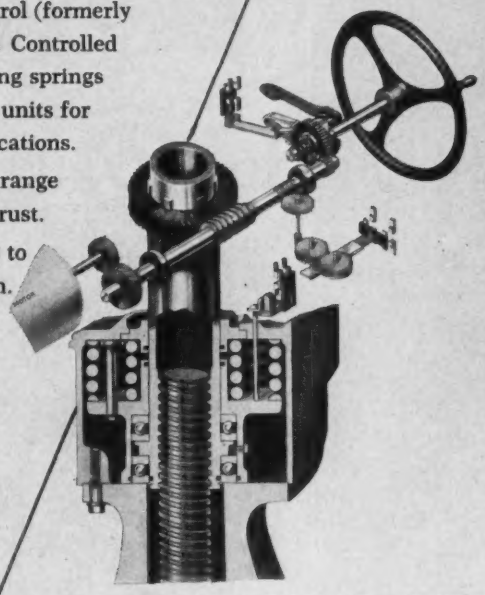
HUPP ELECTRODYNE
AUTOMATIC VALVE CONTROLS

HUPP *Electrodyne* Automatic Valve Control (formerly CUTLER-HAMMER Valve Control) is available in two types: Controlled thrust type units with built-in temperature compensating springs for high temperature service, and controlled torque type units for butterfly and gate valves and other power plant applications.

Controlled Thrust Type TN-Y units have a range of 3,000 to 40,000 pounds thrust.

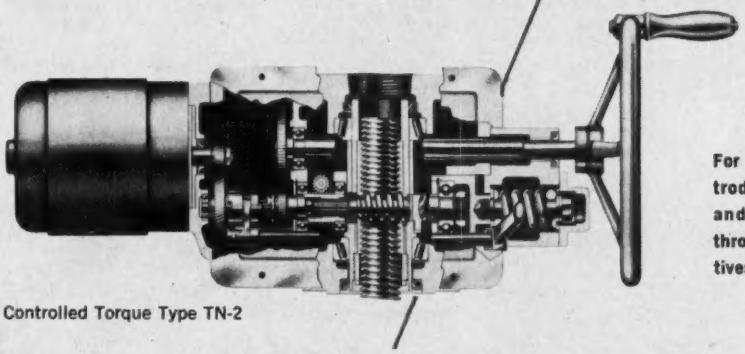
Controlled Torque Type TN-2 units have a range of 3,000 to 300,000 pounds thrust, with larger sizes on application.

The TN-Y Series features a single acting thrust limiting switch which provides for obstruction protection in the seating direction only. The TN-2 Series features a double acting mechanical torque limiting switch which provides for obstruction protection in both directions of valve travel. Both have automatic handwheel declutching mechanisms. Up to sixteen contacts are available for control. Position indicators, position transmitters and receivers are available as optional equipment.



Controlled Thrust Type TN-Y

***ELECTRODYNE** UNITS CAN BE MOUNTED ON EXISTING VALVES*



Controlled Torque Type TN-2

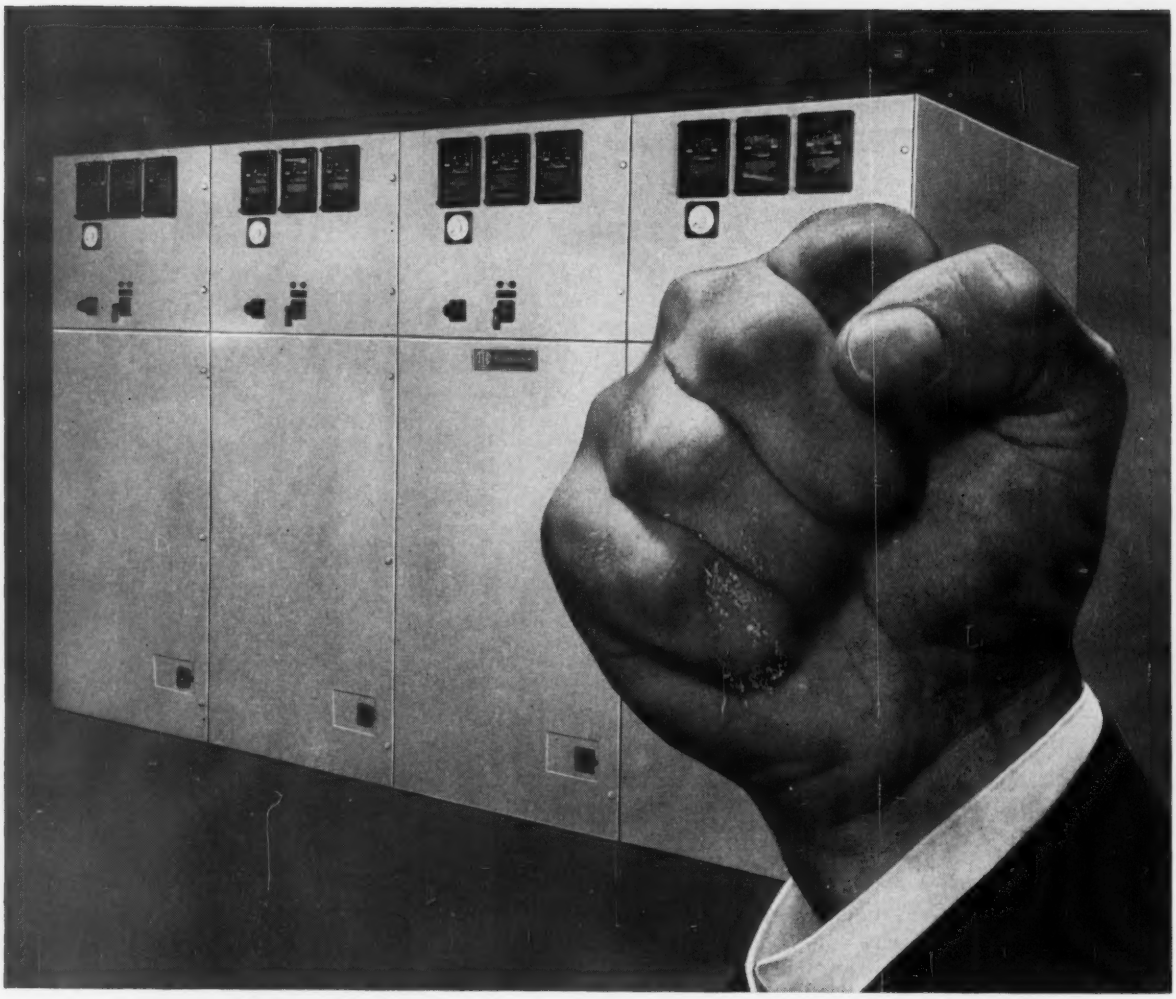
For detailed information, write for Electrodyne Valve Control Bulletins. Parts and service are available promptly through HUPP *Electrodyne* representatives from coast to coast.

HUPP *Aviation Division* HUPP CORPORATION

6633 WEST 65th STREET • CHICAGO 38, ILLINOIS • POrtsmouth 7-2100

ELECTRODYNE VALVE CONTROLS . . . GEAR PUMPS AND MOTORS . . . PRECISION INDUSTRIAL, AIRCRAFT AND MISSILE GEARING AND COMPONENTS

For more facts circle 217 on Reader Service card, p 101



"I hate to spend money on switchgear maintenance!"

Who doesn't. That's why I-T-E designed this completely new 13.8 kv switchgear so that your maintenance costs can be lower than ever.

For example, this is the first 13.8 kv switchgear designed exclusively for stored energy closing. That means it closes fast every time. Contacts last longer, and that keeps down the upkeep. I-T-E's unique ratchet and pawl stored energy mechanism eliminates the need for a brake or clutch which would require periodic maintenance.

The breaker is more compact and actually hundreds of pounds lighter in weight than the previous model. So it's easier to move around, has a lower center of gravity. And one man can do all the maintenance work, including raising the arc chutes and maneuvering the frame.

All secondary wiring is in the front—away from the high voltage bus. You can service it without shutting down the board. Access to instruments is through a separate door to an isolated compartment, for still greater safety.

Low-cost maintenance is only one of the economy features of this new I-T-E 13.8 kv switchgear. It saves space —roughly 30 cu. ft. per frame. Stored energy means you can use a smaller battery or transformer for closing. And you can disconnect the breaker without opening the front doors—saving time in routine operations.

If you are about to specify 13.8 kv switchgear, make sure you get all the advantages only this I-T-E equipment offers. See the new illustrated Bulletin 2800-2B. Call your nearby I-T-E sales office. Or write I-T-E Circuit Breaker Company, 1900 Hamilton St., Philadelphia 30, Pa.

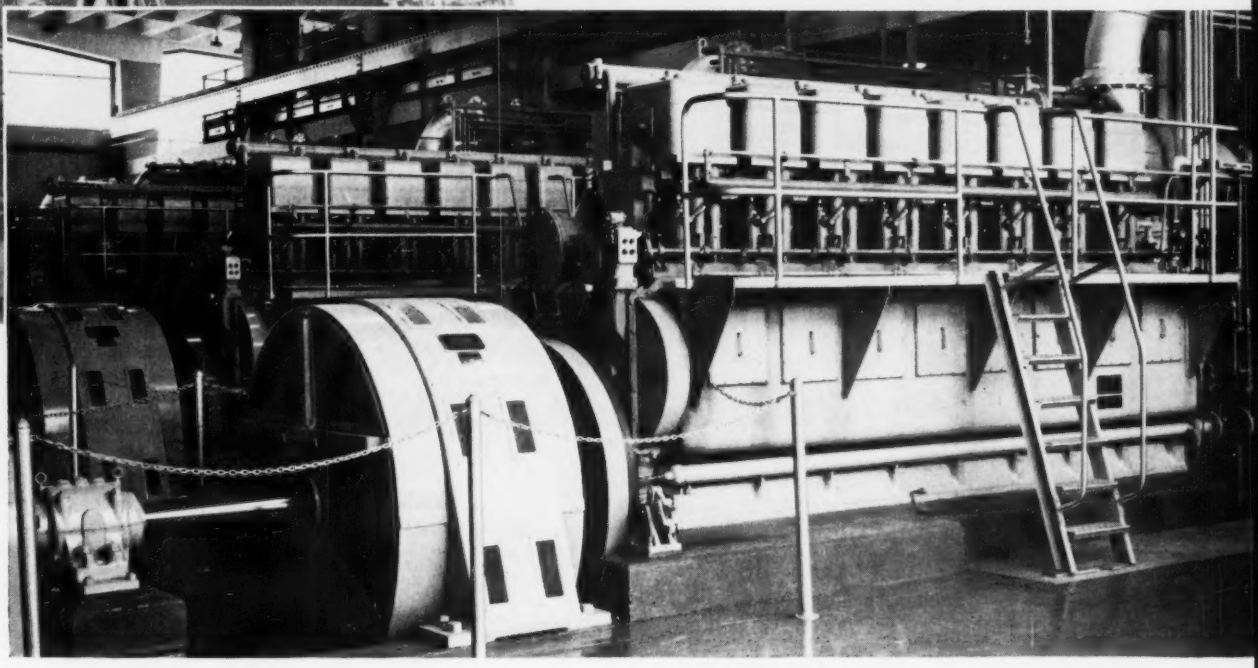
I-T-E CIRCUIT BREAKER COMPANY

For more facts circle 218 on Reader Service card, p 101

circle 219 on Reader Service card, p 101 ➤

ATLAS MISSILE COMPLEX

UNFAILING POWER SUPPLY assured with 6 NORDBERG DIESELS



The locale . . . an isolated point of land jutting into the Pacific Ocean near Los Angeles. Sprinkled through this brush-covered area is the incongruous evidence of the free world's first operating and training base for both intercontinental (ICBM) and intermediate range (IRBM) ballistic missiles. Suddenly, the area has sprouted towering gantries, huge concrete slabs, a busy air field, shops and offices, homes and barracks. This is Vandenberg Air Force Base, which has mushroomed into a populated, multi-billion-dollar aero-space age defense establishment.

The major mission of Vandenberg is to maintain an operational status with ICBM's. The base must be ready at a moment's notice to blast off its "birds" without fail. Vandenberg also serves as a training site for SAC ICBM crews to be deployed at bases throughout the country.

To insure an unfailing power supply, the Atlas Complex includes a modern power plant, comprised of six husky Nordberg turbocharged diesels rated 1344 hp at a conservative 450 rpm, giving the plant a total capacity of 8,064 hp. Each engine drives a 956 kw generator, and the total capacity of over 5700 kw gives the plant plenty of reserve capacity . . . a Nordberg diesel-electric generating plant that assures the world that no electric power failure will delay the gigantic Atlas guided missiles if they must soar into space in any emergency.

NORDBERG MANUFACTURING COMPANY
MILWAUKEE 1, WISCONSIN

NORDBERG MACHINERY

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P660-R

Now...a completely self-cased, MODULAR BOILER

C-E's NEW

DESIGN HIGHLIGHTS OF THE VU-60

Modular construction makes it possible to assemble custom designs from standardized components.

Boiler can be proportioned for best combustion, heat absorption and gas flow even when space conditions are limited or difficult.

Completely self-cased, the VU-60 is an all-welded gas-tight and pressure-tight envelope of finned furnace and boiler tubes. This results in less non-working weight per pound of steam capacity.

No external ductwork. The bottom of the boiler is a plenum chamber which allows air to flow direct from the air heater to the burner windbox.

Number of field-welded pressure parts is greatly reduced.

Cross flow baffling and symmetrical boiler bank mean low draft loss, no sluggish gas flow in any pass.

Requires only a simple, reinforced concrete slab. No conventional roller supports required.

Paneled construction cuts erection time.

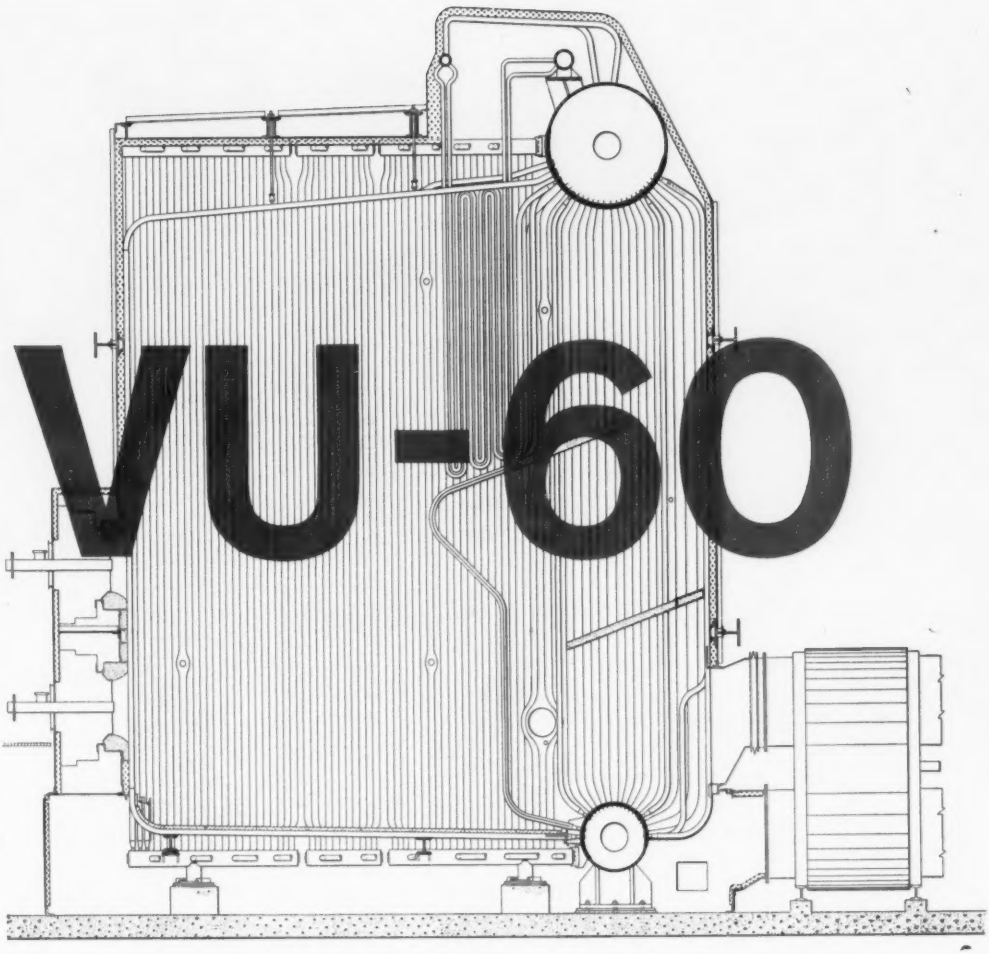
No air heater supporting steel is required.

For pressurized or induced draft firing. When pressurized, unit does not require induced draft fan.

VU-60 SPECIFICATIONS

Capacities:	100,000 to 250,000 lb per hr
Design pressures:	250, 500, 750, 1000 psi
Steam temperatures:	To 900 F
Fuels:	Oil and/or gas
Firing:	Horizontal (front wall) or tangential
Size increments:	Depth — twelve Width — eight Height — three
Steam drum sizes:	Four

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS;



The VU-60 Boiler is a new and logical extension of C-E's service-proved VU series. Like all VU units, it is completely integrated, symmetrical in design, uncluttered and uncomplicated. Based on a standardized modular concept, it offers greater flexibility, yet stays within the bounds of solid and proven practice.

The VU-60 is a functional boiler. Completely self-cased, the exterior walls of this unit (furnace and boiler) are composed of finned tubes, shop welded into panels. The fins between panels are field welded to form a gas- and pressure-tight structure. Insulation is applied directly to the outside of these walls and is covered by pre-formed, field installed metal lagging. Thus non-working weight and bulk is reduced to a minimum.

The VU-60 is economical, it is dependable, it is accessible. It is easy to install and will meet your most exacting steam needs. Why not write for further information, or, if you prefer, contact the C-E office nearest you.

COMBUSTION C·E ENGINEERING

General Offices: Windsor, Conn. • New York Offices: 200 Madison Avenue, New York 16, N. Y.

Canada: Combustion Engineering-Superheater Ltd. C-300

PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

For more facts circle 220 on Reader Service card, p 101

...A SIMPLE RULE-OF-THUMB THAT LETS YOU REDUCE PACKINGS INVENTORY ...AND STILL HANDLE 9 OUT OF 10 VALVE AND PUMP PACKING JOBS!

FOR VALVES, J-M THERMO-CORE® (black) offers excellent heat resistance, maximum sealing under least compression, and adapts readily to equipment variations. For general use, Style No. 397 is recommended. This style consists of Inconel-reinforced asbestos yarns . . . braided over a soft center core of graphite and 100% white asbestos.

FOR PUMPS, J-M CHEMPAC® (white) combines the excellent sealing and heat-resistant qualities of asbestos with Teflon's immunity to almost all chemical and solvent action. Chempac Style No. 2009 is recommended to give you long, efficient and economical service on the majority of your pump, expansion joint and agitator applications.

For special conditions – or for any other mechanical packings application you can name–Johns-Manville produces the industry's most complete range of packing styles. These are described in J-M's new 64-page Mechanical Packings Book. It is designed to help you select the packing best suited to each particular requirement. For a free copy of PK-131A, write to Johns-Manville, Box 14, New York 16, N. Y. In Canada, address Port Credit, Ontario. Cable address: Johnmanvil.

JOHNS-MANVILLE JM PRODUCTS

For more facts circle 221 on Reader Service card, p 101

YOUR CALENDAR OF

MICRO POWER "no-break" POWER EVENTS FOR 1961

..by UNITED STATES MOTORS CORPORATION

1ST QUARTER

New BRUSHLESS GENERATORS

U. S. Motors 5 to 20 kw capacity Micro Power units will feature new "brushless" generators to eliminate brush and slip ring maintenance requirements. The no-break units will also operate at plus or minus 1 per cent voltage regulation to satisfy increasing sensitivity of critical operating equipment.

2ND QUARTER

New 5 KW DIESEL MICRO POWER

5 KW capacity "diesel" Micro Power units will be available to fulfill growing demand for a thoroughly dependable power supply unit of smaller capacity.

3RD QUARTER

New LARGER SELECTION

The most complete selection of Micro Power units ever offered will be ready by the second half of '61. Included will be 1½-3 kw gas, or gasoline units — 5, 10, and 15 kw gas, gasoline, or diesel units — 20, 30, 50, 75, 100, 150, 200, and 300 kw capacity diesel units.

4TH QUARTER

New COMBINATION AC/DC UNITS

For the first time, combination AC/DC Micro Power units will be offered in 3 kw and larger capacities with 48 or 129 volt DC current for energizing transistorized microwave communications equipment, and 120/240 volt AC current for handling non-critical power needs.

GROWING STEADILY TO MEET YOUR MOST CRITICAL POWER REQUIREMENTS

1952
First Micro Power Unit.

1953
Intensified design and testing program initiated.

1954
First shipments of 3 KW gas, gasoline Micro Power.

1955
First shipments of 5 KW gas, gasoline Micro Power.

1956
First shipments of 10 KW gas, gasoline Micro Power.

1957
First diesel Micro Power Unit.

1958
Further expansion of research-testing program. First 50 KW Micro Power Unit unveiled.

1959
First shipments of 10 KW diesel Micro Power. 100 KW unit designed.

1960
Over 2000 units in operation. Larger capacities on the way.

authorized sales and service representatives in

CHICAGO, Ill. • DALLAS, Tex. • DENVER, Colo. • DETROIT, Mich. • JACKSONVILLE, Fla.
JERSEY CITY, N. J. • LOS ANGELES, Calif. • PORTLAND, Ore. • SAN FRANCISCO, Calif.

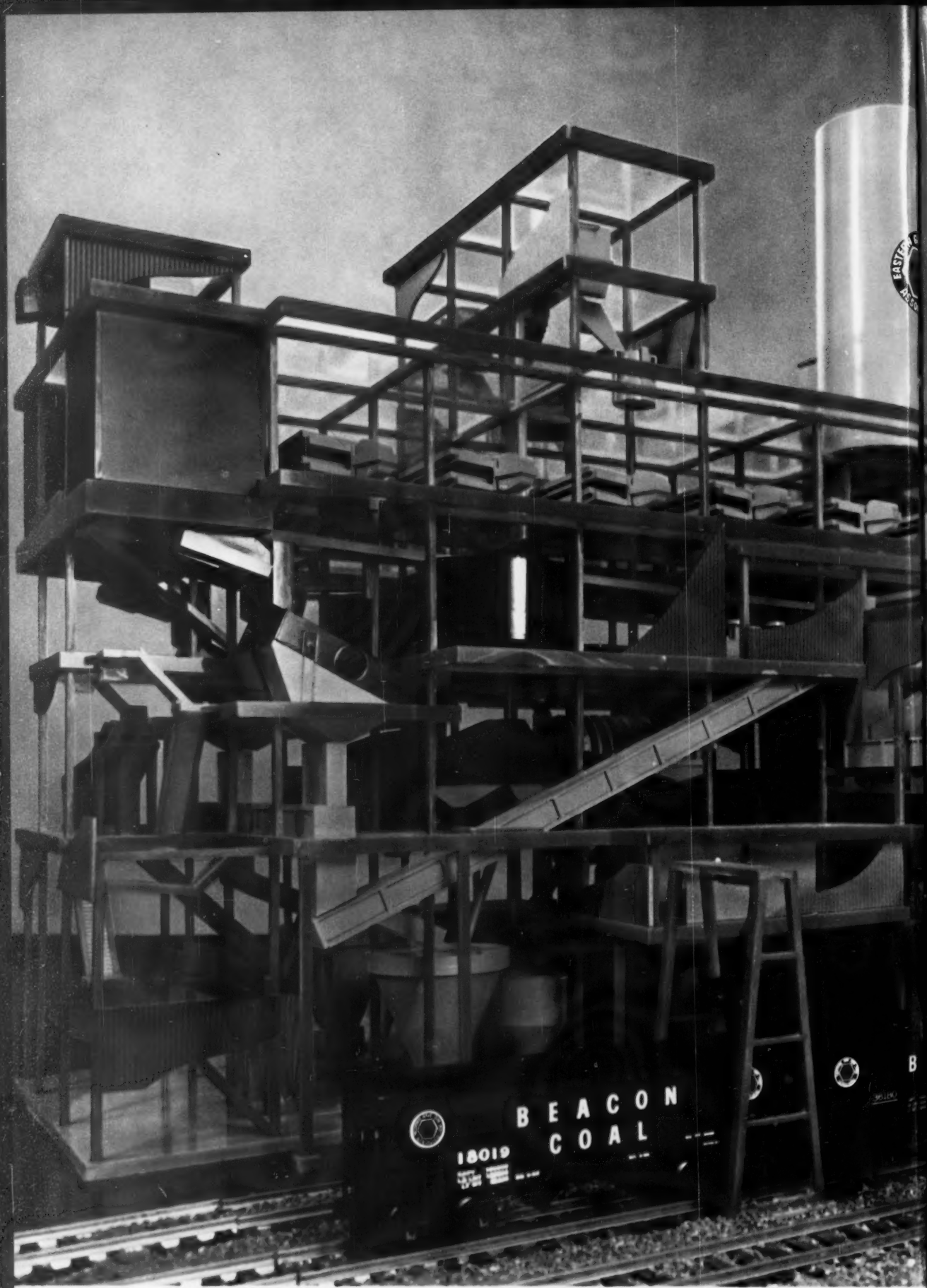
consult the classified section of your phone directory

UNITED STATES MOTORS CORPORATION
MICRO US POWER
OSHKOSH • WISCONSIN

UNITED STATES MOTORS CORPORATION
102 West Fifth Avenue • Oshkosh, Wisconsin

circle 222 on Reader Service card, p 101

circle 223 on Reader Service card, p 101 ➤



This cutaway scale model shows the tipple construction of our new cleaning plant operation. It is now under construction at our Federal No. 1 mine at Grant Town, West Virginia.

WE ARE BUILDING A NEW CLEANING PLANT

. . . better, cleaner coal will come from this Eastern Gas and Fuel 12,500 tons-per-day new facility

With the completion of the new processing plant at Federal No. 1 mine, we will have the most modern facilities in the Fairmont, West Virginia, coal field. Designed to handle 825 tons-per-hour of raw coal, the new cleaning plant will produce 12,500 tons-per-day of completely cleaned, dried coal in a wide range of sizes.

The plant will be equipped with the most modern machinery for cleaning and sizing the coal. Deister tables, froth cell units and heavy media separation will be used to purify the coal, and several types of dryers and dewatering equipment provide a low moisture content finished product.

Most of the processes within the plant are automatic, including sampling of each size of coal, which provides excellent quality control.

This addition to our facilities reaffirms our faith in the future of coal and our determination to continually improve our product. It underscores, too, a recognition of customer's needs and the ever expanding demand for quality coal. The new plant is now under construction, and is expected to be in full operation in early 1962.

Any Eastern representative will be glad to explain in detail how this new plant can be of service to you. Offices located in Pittsburgh, Boston, Cleveland, Detroit, New York, Norfolk, Philadelphia and Syracuse.

EASTERN GAS AND FUEL ASSOCIATES

EASTERN GAS AND FUEL ASSOCIATES

to cooling: a solution

By trunk or by tower, evaporative cooling has proved its practicability. Contributing to the effectiveness of this method of industrial cooling is the Peerless vertical industrial service pump. Efficient, versatile and economical, the Peerless vertical pump offers optimum performance in all ranges, plus these *extra value* Peerless features: *unitized pump-motor manufacture*, for perfect alignment, increased pump durability; *improved suction manifolding* for better water intake, less friction; *advanced vertical turbine design* for highest efficiency, maximum performance; *designed-in flexibility* of a modern pump, for easy adaptation for future system requirements.

PEERLESS PUMPS

WRITE FOR ILLUSTRATED BULLETIN NO. B-505

Putting Ideas to Work

fmc

FOOD MACHINERY AND CHEMICAL CORPORATION

Peerless Pump · Hydrodynamics Division

Plants: LOS ANGELES 31, CALIFORNIA and INDIANAPOLIS 8, INDIANA

Offices: New York; Atlanta; St. Louis; Phoenix; San Francisco; Chicago; Fresno; Los Angeles; Plainview and Lubbock, Texas; Albuquerque. Distributors in Principal Cities. Consult your telephone directory.

For more facts circle 224 on Reader Service card, p 101

NOW... THE LONGEST SEAMLESS STEEL TUBING IN THE INDUSTRY!

New facilities at our plants in South Lyon, Michigan, and Rosenberg, Texas, are now producing the longest seamless steel tubing in the industry—in lengths of 85 feet or more, for use in feedwater heaters, in nuclear power plants, wherever high-pressure application is required.

Michigan Seamless alloy and carbon steel tubing, TAILORED TO THE JOB, has proven advantages over non-ferrous tubing. For example, in high-pressure feedwater heaters, steel tubing eliminates costly shutdowns due to copper deposit in the boiler or on turbine blades. Operating data from plants now using steel tubing in feedwater heaters, shows that corrosion is negligible even when intermittent on-line time is necessary. And the first cost of a heat exchanger tubed with steel is at least 20 percent less than one tubed with non-ferrous!

For information on how steel tubing can improve your feedwater heater design, write or wire Michigan Seamless Tube Company, 402 West Street, South Lyon, Michigan.

U-TUBES

Order from one source: Long tubing, TAILORED to your specifications and U-bent to fit your design, shipped on pallets, ready for installation.

MECHANICAL, AIRCRAFT, PLAIN AND FINNED HEAT EXCHANGER TUBING

MICHIGAN SEAMLESS TUBE COMPANY/GULF STATES TUBE CORPORATION

SOUTH LYON, MICHIGAN — ROSENBERG, TEXAS

HIGH-PRESSURE JETS BLAST DEPOSIT-PACKED BUNDLES CLEAN AS NEW

The high-pressure jet unit below is blasting solidly-caked deposits from a heat exchange bundle . . . removing substantially all traces of deposits throughout the bundle, without cutting it apart!

Nation-wide Dow Industrial Service developed this automatic unit to remove scale, coke and asphalt deposits without metal erosion or wall thinning. This is just one of many advanced tools and techniques developed by Dow Industrial Service to clean equipment of every kind... boilers, pipelines, chemical process equipment, towers, scrubbers.

D. I. S. engineers first analyze your problem, then pick the most effective cleaning method . . . whether chemicals, steam, jet, foam, or other means. D. I. S. tailors the technique to give you most value per dollar.

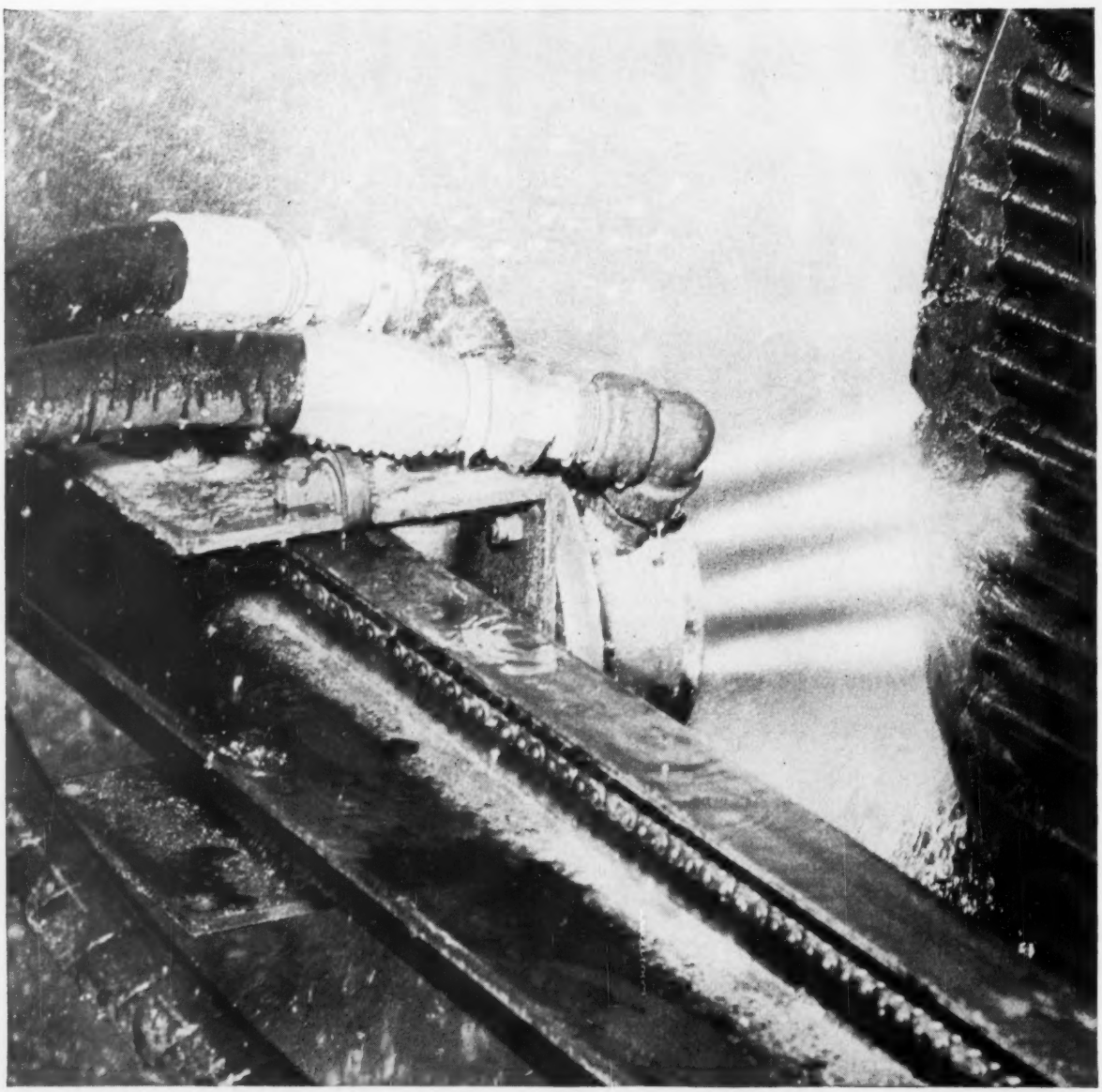
In addition, D. I. S. offers complete consulting laboratory service for water treatment and waste processing problems, backed by the technical resources of The Dow Chemical Company.

D. I. S. is a nation-wide industrial service . . . and offers "total" cleaning. For cleaning equipment of *any* kind, *anywhere*, call D. I. S. We'll be glad to show you how to set up a year 'round cleaning program to *keep* equipment operating at top efficiency. Write or call DOW INDUSTRIAL SERVICE, 20575 Center Ridge Road, Cleveland 16, Ohio.

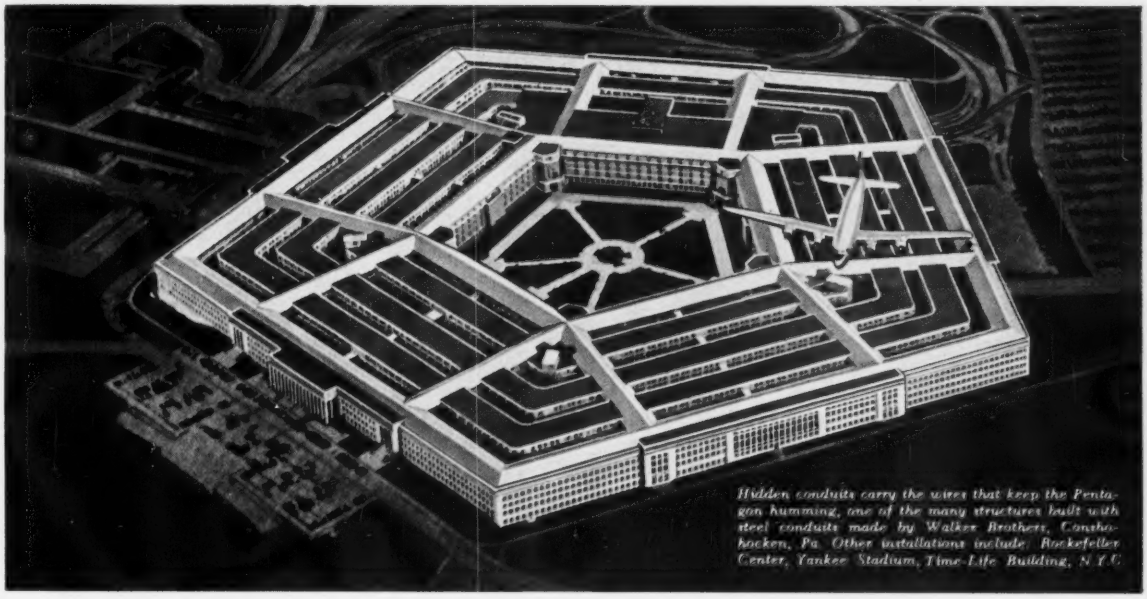
DOW

Automatic jet unit removes bundle deposits, without dismantling.

DOW INDUSTRIAL SERVICE • Division of The Dow Chemical Company



For more facts circle 232 on Reader Service card, p 101



Hidden conduits carry the wires that keep the Pentagon humming, one of the many structures built with steel conduits made by Walker Brothers, Conshohocken, Pa. Other installations include: Rockefeller Center, Yankee Stadium, Time-Life Building, N.Y.C.

Sel-Rex Rectifier Helps Walker Brothers Meet Up-To-The Minute Delivery Schedules!!

The Pentagon, as with many modern structures, is honeycombed by thousands of Walker Brothers conduits and ducts that carry miles of telephone, dictaphone and low voltage electrical wiring.

Getting these tons of rigid steel conduit to the initial construction site calls for adherence to precise building schedules—timing deliveries to meet contractors' hoist schedules. Otherwise costly delays result; deadlines are disrupted.

Walker Brothers Conduit Division, Conshohocken, Pa., assures on-time deliveries with the help of a Sel-Rex Silicon Rectifier. It powers the plant's giant overhead cranes that lift, haul and load tons of steel every day.

The rectifier was chosen for a special reason: when the company's motor generator suffered a breakdown, a virtually complete production shutdown resulted. To prevent a recurrence, Walker selected a Sel-Rex Rectifier to supply its D.C. requirements . . . chosen because "it has no rotary parts to wear out, has low installation cost, negligible maintenance and low operating cost."

These statements from a Walker Brothers official make good sense. They are the same sound reasons why thousands of firms have chosen Sel-Rex Rectifiers as their modern, trouble-free source of dependable D.C. power.

Tons of steel conduit made at the Conshohocken, Pa. plant of Walker Brothers are carried by overhead cranes powered by a Sel-Rex Silicon Rectifier.

Send for Free "GUIDE" to Industrial Rectifier Equipment

SINCE MEAKER 1899

THE MEAKER COMPANY

SUBSIDIARY OF Sel-Rex SEL-REX CORPORATION

Nutley 10, New Jersey

Factories and Offices Chicago 50, Ill., Los Angeles, Cal. and Nutley 10, N. J.

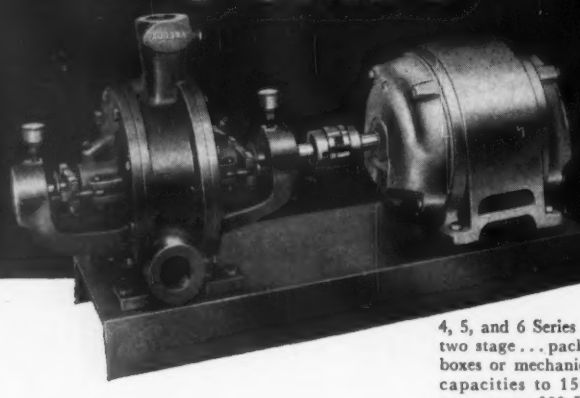
Representatives in principal cities.

Complete Semi-Conductor Power Conversion Equipment and Systems for any AC to DC Application

For more facts circle 233 on Reader Service card, p 101

MAXIMUM EFFICIENCY • LONGER SERVICE LIFE
• EASIER MAINTENANCE WITH

AURORA® APCO TURBINE TYPE PUMPS



4, 5, and 6 Series . . . single or two stage . . . packed stuffing boxes or mechanical seals . . . capacities to 150 GPM . . . pressures to 300 PSI. Ask for Bulletin No. S-111.

★ Long service life . . . with no metal-to-metal contact within the pump channel, wear is minimized.

★ *Easy Maintenance* . . . removal of end covers permits complete disassembly without breaking or disturbing the suction or discharge connections or motor-pump alignment.

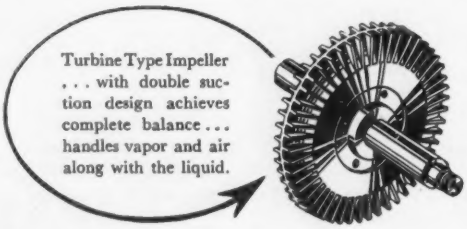
★ Complete hydraulic balance . . . achieved with double suction design . . . all hydraulic thrust on outboard bearings is eliminated.

★ Will not vapor bind . . . turbine type impellers handle vapor and air along with the liquid to eliminate vapor lock within the pump.

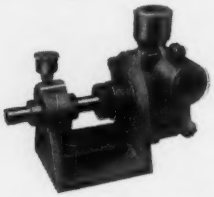
★ Wide operating range . . . constant capacity is maintained over wide head variations or fluctuating conditions—adjust quickly to changed operating conditions.

★ Ideal for low capacity, high pressure applications . . . boiler feed, condensate return, circulation services, booster services, LPG service, liquid transfer, water treatment, and filter services.

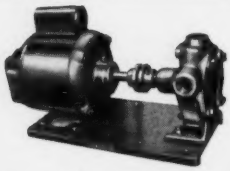
WRITE TODAY FOR FREE DESCRIPTIVE LITERATURE!



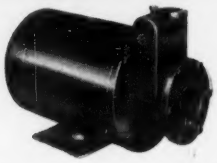
Turbine Type Impeller . . . with double suction design achieves complete balance . . . handles vapor and air along with the liquid.



3 Series . . . Single stage . . . packed stuffing box . . . flexible coupling drive . . . capacities to 12 GPM, heads to 50 feet. Ask for Bulletin U-111-A.

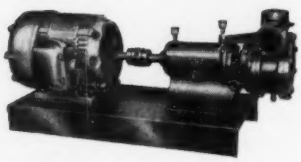


32 Series . . . single stage flexible coupling drive . . . mechanical seal . . . lubricated-for-life bearings . . . capacities to 10 GPM, heads to 250 feet. Ask for Bulletin U-111-B.

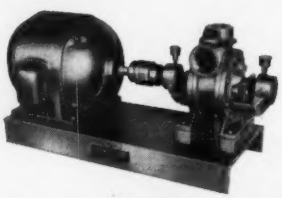


Type V31 . . . single stage close coupled . . . mechanical seal . . . self priming . . . capacities to 15 GPM, heads to 350 feet. Ask for Bulletin V-111-A.

Type V4 . . . close coupled . . . single stage . . . mechanical seal . . . capacities to 30 GPM . . . heads to 350 feet. Ask for Bulletin V-111-B.



Type Z4 Chemical Process . . . single stage or two stage . . . mechanical seal . . . capacities to 50 GPM . . . pressures to 400 PSI. Ask for Bulletin Z-111-A.

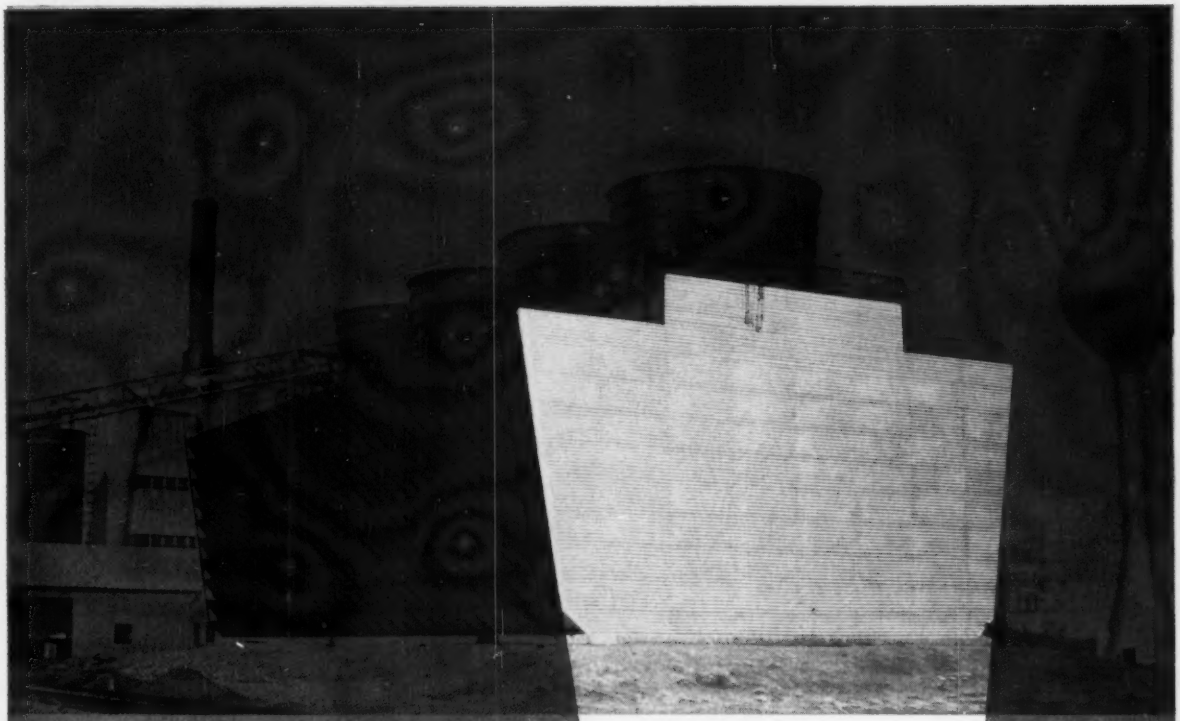


Type X40 . . . water jacketed packed stuffing boxes or mechanical seals . . . single or two stage . . . capacities to 60 GPM . . . heads to 350 feet. Ask for Bulletin 111XJ.

AURORA Always PUMPS

AURORA PUMP DIVISION
THE NEW YORK AIR BRAKE COMPANY
1000 LOUCKS • AURORA, ILLINOIS

LOCAL DISTRIBUTOR IS LISTED IN THE YELLOW PAGES OF YOUR PHONE BOOK



Contour of Quality!

In a Marley Class 600 Double-Flow tower, predetermined performance is as characteristic as its functionally angled profile. At Earl F. Wisdom Station of Corn Belt Power Cooperative, testing proved again why the Class 600 contour is now accepted as the symbol of ability to meet or exceed specified cooling capability. This new 30,000-g.p.m. tower selected by Stanley Engineering Company has joined the long list of *successfully tested* Class 600's, a record that is published annually.

The Class 600 contour also signifies other important design advantages: One of the most outstanding of these is the excellent balance of air volume and air velocity that permits largest capacity per fan cell. The end result is low required horsepower; less mechanical equipment; reduced maintenance cost. Further, the distinctive shape points up a high standard of durability established by liberal use of non-corrosive materials at critical points throughout Class 600 structure.

In a Class 600, quality and stamina are *evident* at a glance, *obvious* on careful examination. Evaluation amplifies the sum of these features as a value unequalled both for long term investment and for profitable plant operations.

THE MARLEY COMPANY ● KANSAS CITY MISSOURI

For more facts circle 229 on Reader Service card, p 101

Circle 230 on Reader Service card for following ad ➤

The Story of Edward Research

and the "Perfect" Globe Valve

Edward designers built the Figure 848 forged steel globe valve from scratch. In an art where most development effort must be directed toward modification, adaptation, and refinement of existing technology, the 848 story is almost unique. The objective was simple: To design and construct a perfect 600-lb-class globe valve in the ¼″ to 1″ size range. (Basic rating 600 lb at 910 F, 2000 lb WOG.) That the project was virtually successful is a tribute to the ingenuity of the Edward Research Staff and the equipment which enabled them to validate their progress. Here, is that story.

Three areas were given special consideration by the Edward staff of engineers and metallurgists when they set out to design a "perfect" valve. They were: 1. Body Shell and Bonnet Joint; 2. Seat Tightness; 3. Packing Area. Although each area was treated separately, the relationship of one to the other was a factor that had a great deal to do with the outcome of the project.

A series of "torture" tests such as the pressure pulsator shown on the opposite page carried each part and joint to the point of destruction. Thus Edward designers were able to trace each weakness to its source. Perhaps no other valve ever designed has been known and understood so well by the men who designed it.

1. BODY SHELL AND BONNET JOINT. The valve bonnet was bolted finger tight; it tested at 2000 psi. Then, at full design tightness on all four bolts, the bonnet joint did not leak until 11,000 psi (5½ times design pressure!) was applied. Next, 8000 psi applied 100 consecutive times produced no apparent valve damage. Internal pressure was pulsated from 200 to 2000 psi for 10,000,000 cycles with no apparent damage!

The bonnet cap screws were subjected to 350% of design tightness before failure occurred. Further evidence of design effectiveness was the unpredictability of failure. In one case the threads stripped; in another the bolts broke off, and in other there was excessive bending of the bonnet flange. There was no *one* apparent point of weakness!

2. SEAT TIGHTNESS. Similar destructive tests were conducted on the valve stem and seat. The valve required on 65% of standard test closing torque to seal tight at 2000 psi. And 350% of standard torque was built up before the stem sheared below the handwheel. 100 operations at 2½ times standard torque did only negligible damage to seating surfaces. Even after this test only 90% of standard test torque was needed to hold 2000 psi.

3. PACKING AREA. Six times as much load as actually required to seal the packing chamber was applied to the gland bolts without causing damage. A load 3½ times greater than required for sealing was applied 50 times, also without causing damage.

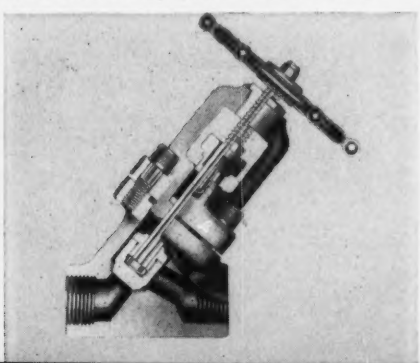
Thus the "perfect" globe valve was designed; perfect not because it can't fail, but perfect because it has no apparent weaknesses. The full design and construction story is told in Edward Catalog 14-G.

Edward builds a complete line of forged and cast steel valves from ¼″ to 24″ for industrial, marine, petroleum and technological services. For more detailed information, contact your Edward Representative, or write Edward Valves, Inc., 1230 West 145th Street, East Chicago, Indiana. Subsidiary of Rockwell Manufacturing Company. Represented in Canada by Lytle Engineering Specialties, Ltd., 438 St. Peter Street, Montreal.

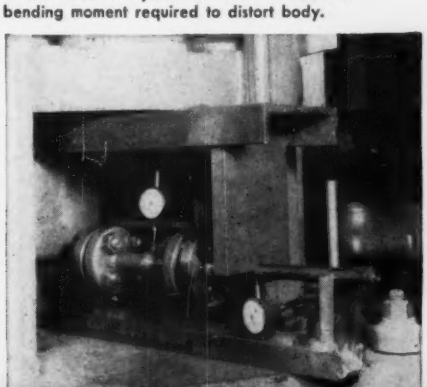
EDWARD STEEL VALVES
another fine product by
ROCKWELL

Chief Engineer C.A. Siver and **Design Engineer Don Easton** observe effects of pulsating pressure on newly designed Figure 848 forged steel globe valve in Rockwell-Edward Research Lab.

Rugged forged steel body . . . combined with high-strength stainless steel gland bolts and bonnet bolts, aluminum-bronze alloy yoke bushing, asbestos-stainless spiral gasket and other premium features . . . makes the Figure 848 a virtually "perfect" small steel valve.

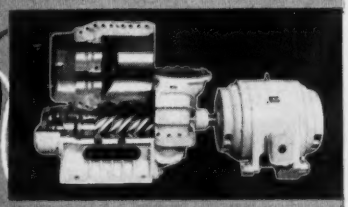


Test arrangement produces uniform bending moment on valve and ½″ pipe. Test shows that the strongest pipe likely to be attached to the valve will yield with less than ⅓ the bending moment required to distort body.



NOW!

PROVED MECHANICAL SIMPLICITY TO REDUCE YOUR COSTS BY PREVENTING SHUT-DOWNS!



F-M ROTARY COMPRESSORS

FAIRBANKS-MORSE leadership shows again...with an advanced European concept to produce a truly unique aid-to-industry...our proved **AXIAL FLOW ROTARY COMPRESSOR** with Helical-shaped rotors! No reciprocating parts! No valves! No metal-to-metal contact provides maximum reliability...with high efficiency...at minimum costs!

- **HELICAL-SHAPED ROTORS . . . BY FAIRBANKS-MORSE**
  Smooth, economical compression with OIL-FREE delivery!
- **DEVELOPED IN SWEDEN! PROVED IN EUROPE! WIDELY USED IN U.S.A.!**
  Now—Fairbanks-Morse is in full production on our revolutionary Rotary Compressor . . . at our large Beloit, Wisconsin plant. The leaders of AMERICAN industry now use our Rotary Compressor . . . with PROVED results!
- **CAPACITY UP TO 21,000 CFM—PRESSURE UP TO 250 PSIG**
  . . . with a standard line of integrated frame sizes!
- **MECHANICAL SIMPLICITY! LOW MAINTENANCE REQUIREMENTS! HIGH EFFICIENCY!**
- **SMALL SPACE REQUIREMENTS—LOW WEIGHTS! MINIMUM VIBRATION!**
- **STABLE PERFORMANCE CHARACTERISTICS! SPEED FLEXIBILITY!**
- **FAMOUS FAIRBANKS-MORSE QUALITY!**
- **A VERSATILE ASSET TO MANY OPERATIONS!**

Our new Compressor is your logical choice for a wide variety of applications:

- Chemical and petrochemical process industries • Refinery process industries
- Heavy mass-production industries • Steel industry—coke oven gas compression
- Many other general purpose industrial and process uses.

Discover How The New F-M Rotary Compressor Can Step Up The Efficiency of YOUR Operations and Cut Down Maintenance Costs: Send for your copy of the New Fairbanks-Morse Compressor Bulletin Number ACO100.4.

Write to A. C. English, General Manager, Compressor Division
Fairbanks, Morse & Company
600 South Michigan Avenue, Chicago 5, Illinois

Fairbanks Morse

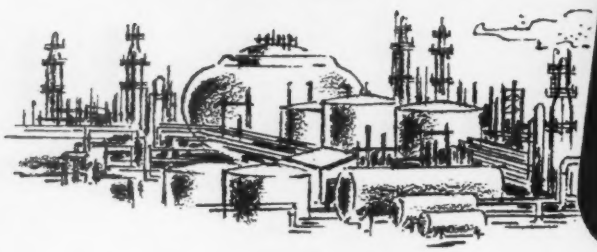
Compressor Division

A MAJOR INDUSTRIAL COMPONENT OF
FAIRBANKS WHITNEY CORPORATION

For more facts circle 231 on Reader Service card, p 101

Portable MINIMITE® Goes Anywhere

for Accurate Temperature – Millivolt Measurement



Take accurate temperature-millivolt measurements wherever you go—laboratory, plant or field—with the rugged, compact, portable "MiniMite". Moderately priced, the "MiniMite" (null-balance potentiometer pyrometer) weighs just 3½ lbs., measures just 4″ x 5″ x 6″, provides ¼ of 1% of scale accuracy with a long 23.6″ double range scale. Widely spaced scale graduations facilitate easy, accurate reading. A standard flashlight battery provides standardization.

Measure Temperatures Directly

Connected to a thermocouple, the "MiniMite" provides accurate temperature indication, anywhere. It is used for standard checking and calibrating procedures. Automatic cold-junction compensation is built-in.

Measure Millivolts Directly

Any transducer with a dc millivolt output can be checked quickly with the "MiniMite".

Calibrate Other Instruments

The "MiniMite" can be used to check or calibrate potentiometer or millivoltmeter type recorders, indicators, controllers, easily—with little or no extra equipment.

Special Design

An adaptation of the "MiniMite", called the Airline "MiniMite", is made to quickly check dynamic performance characteristics of jet engine exhaust temperatures, E.G.T. spread or average and calibrate cockpit indicators. It also can be used as a source of variable dc millivolts.

72 Double Range Scales

Range Scales for the "MiniMite" can measure temperatures from minus 450°F. to plus 3200°F. with all standard thermocouple materials, including various Platinum-Rhodium combinations. Many millivolt scale ranges are available. The double range scales are available with two different thermocouple calibrations, combinations of a temperature and millivolt range, or a single temperature or millivolt scale.

Operation is Easy

Anyone can obtain accurate readings quickly. Connect the "MiniMite" to a sensing element or instrument to be checked, standardize and adjust for readings.

You can have delivery of the model, and range scales you need promptly, many are carried in stock.

Write today for information—Instrument section 64- 42

Thermo Electric

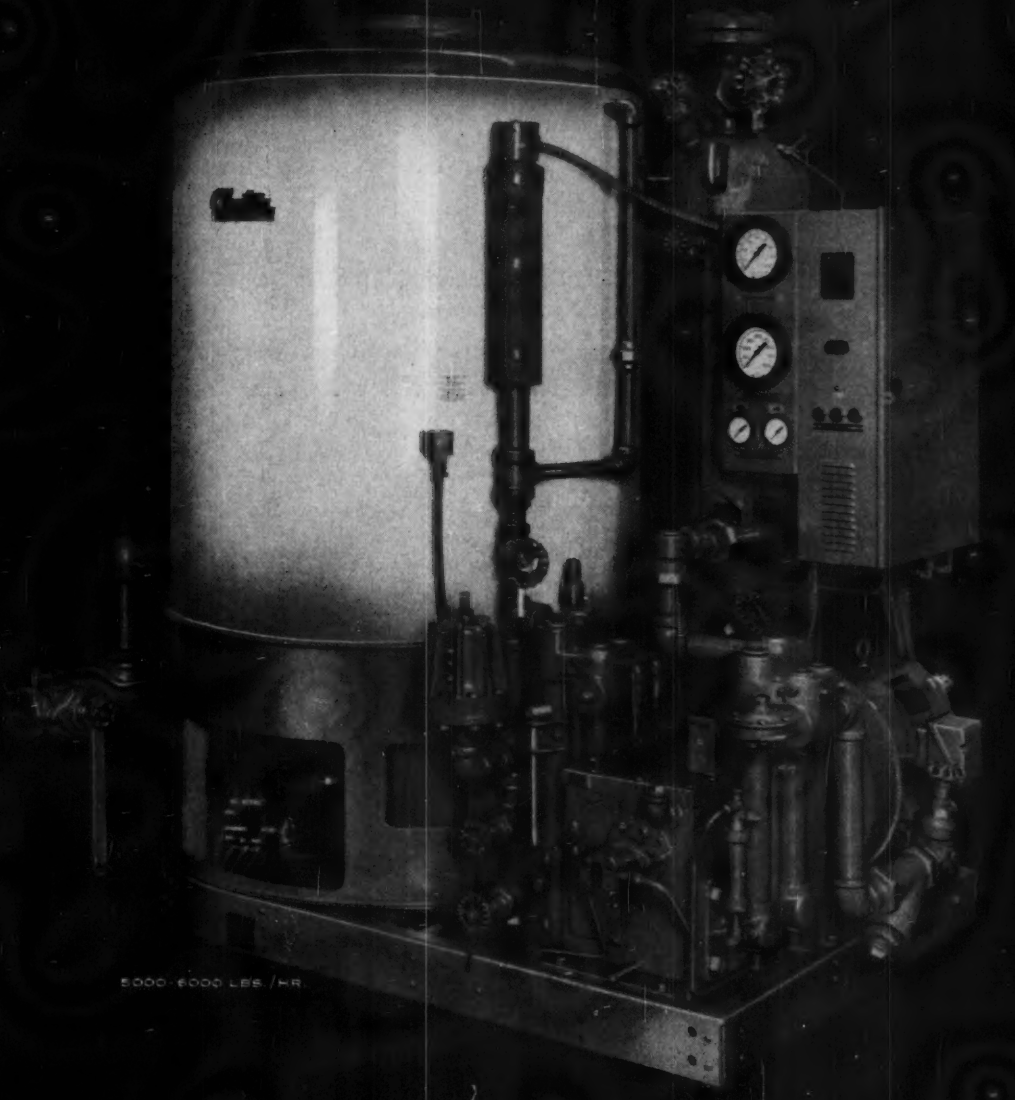
Temperature Measuring Systems and Components

THERMO ELECTRIC Co., Inc., Saddle Brook, New Jersey
In Canada: THERMO ELECTRIC (Canada) LTD., Brampton, Ont.

For more facts circle 226 on Reader Service card, p 101

circle 227 on Reader Service card, p 101 ➤

STEAM THE MODERN WAY



CLAYTON STEAM GENERATORS

Up in performance—Down in size

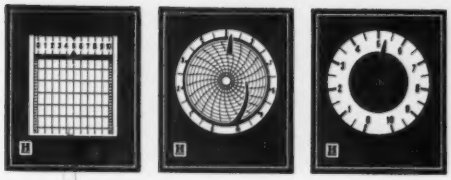
Sizes from 16½ to 175 HP • All sizes 65 to 195 psi • Larger sizes 85 to 295 psi • Gas, light or heavy oil, or in combination • Requires no more space than an ordinary conference table.

Clayton MANUFACTURING COMPANY

EL MONTE, CALIFORNIA • CINCINNATI, OHIO

the advanced, all-new ElectroniK 17

NO SLIDEWIRE, NO SLIDEWIRE PROBLEMS. The unique STRANDUCER rebalancing element replaces the conventional slidewire. It works on the strain gage principle and consists of four looped wire strands which form the resistance legs of a Wheatstone bridge. Both STRANDUCER and pen carriages are linked to the potentiometer balancing motor. A change in electrical input causes the balancing motor to change the tension—and electrical resistance—of the STRANDUCER, to reposition the instrument pen or pointer. The STRANDUCER is unaffected by corrosive atmospheres and has no contactors. It has unusually long life and infinite resolution and is unaffected when the instrument operates in ambient temperatures up to 130° F.



will save you more time, trouble, dollars, and maintenance than any other potentiometer on the market today!

- New *STRANDUCER** replaces slidewire
- New control system with plug-in units
- New modular construction
- New economy

. . . and other pace-setting features

ElectroniK 17 potentiometers are completely new Honeywell recording and control instruments, compact enough to fit standard 19-inch relay racks. They perform reliably, have $\pm 0.25\%$ calibrated accuracy and incorporate new design advances which make them the easiest of all potentiometers to operate, convert, and maintain.

You can get *ElectroniK 17* instruments as strip or circular chart recorders or circular scale indicators. You can get electric contact control with up to 8 contacts. Control units are of plug-in type.

With *ElectroniK 17* potentiometers, you not only get uninterrupted performance, but also save money in initial cost, operating expense, and maintenance. You will find this new potentiometer far more economical to operate than any other available today.

For complete information on the *ElectroniK 17*, call your nearby Honeywell field engineer or write to MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa. — In Canada, write Honeywell Controls, Ltd., Toronto 17, Ontario.

Honeywell

First in Control

SINCE 1885

MODULAR CONSTRUCTION, PLUG-IN COMPONENTS

make ElectroniK 17 easiest of all potentiometers to operate, convert, maintain.

INTERCHANGEABLE DISPLAY MODULE. You can switch easily from strip to circular chart, to circular scale operation . . . reduce your spare parts inventory because you can stock a single spare module for several instruments.

FRONT ADJUSTMENTS. You adjust damping and gain from the front of the instrument, using only a screwdriver.

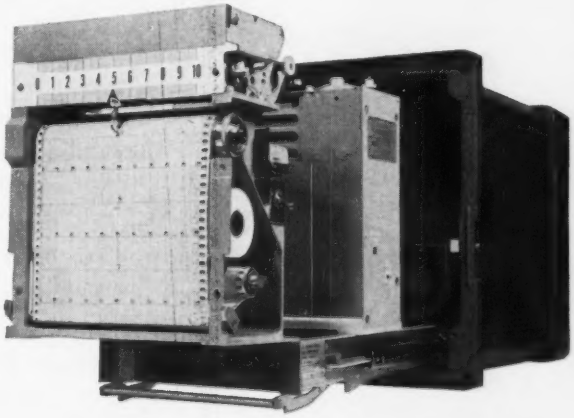
QUICK-CHANGE DRIVE GEARS. You can change chart speed to ½ or 2 times basic speed in a matter of seconds by replacing quick-change drive gears. Standard chart speeds: 1, 2, 6, 10, or 60 inches per hour.

EASY RANGE AND ACTUATION CHANGE. Simply change range card attached to actuation board. Universal reference junction compensator serves *all* types of thermocouples; you can quickly remove it to convert to some actuation other than thermocouple. Filter network rejects loop stray signals.

PULL-OUT CHASSIS AND EXTERNAL TERMINAL BOARD. You can pull out the chassis to the service position without tools and without interrupting the operation of the instrument, or completely remove it.

COMPACT EASILY-REMOVED TRANSISTOR AMPLIFIER. With only a screwdriver you can remove the amplifier for servicing.

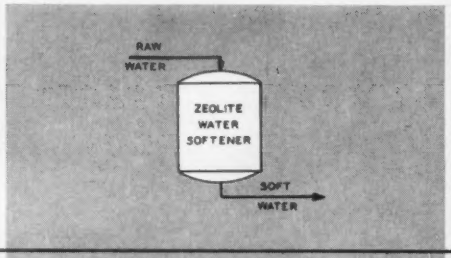
NO STANDARDIZATION. Zener diode constant current unit does away with need for battery and standardizing mechanisms.

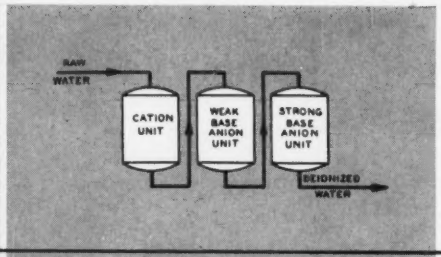


**Trademark*—Minneapolis-Honeywell Reg. Co.

HONEYWELL INTERNATIONAL Sales and Service offices in all principal cities of the world. Manufacturing in United States, United Kingdom, Canada, Netherlands, Germany, France, Japan.

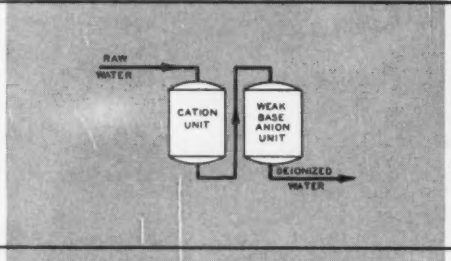
Delivers soft water by the simplest and most dependable method of softening water—the zeolite softener.

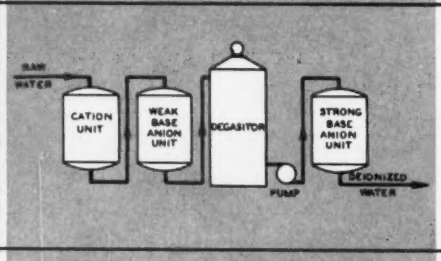




Delivers high quality CO_2 and silica free deionized water. Used to treat water of relatively low alkalinity.

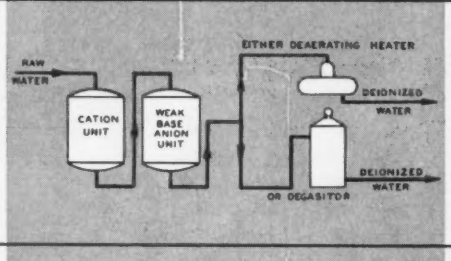
Delivers deionized water low in dissolved solids—suitable for many boiler and process applications.

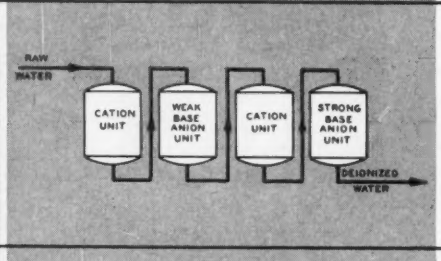




Delivers deionized water, free of CO_2 and silica. Very effectively used for waters of high alkalinity.

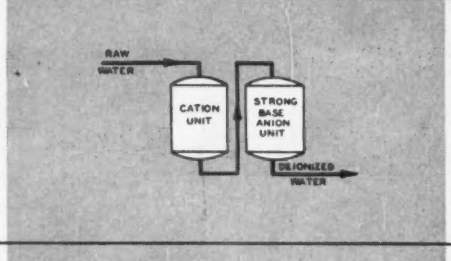
Delivers deionized water and eliminates CO_2 with either deaerating heater or degasitor.

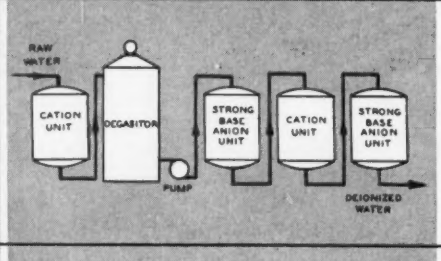




Delivers exceptionally high quality deionized water, free from silica and CO_2. Effectively used on waters of low alkalinity.

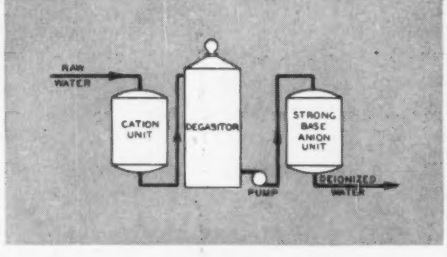
Delivers deionized water free from silica and CO_2. Used largely for waters of low alkalinity.

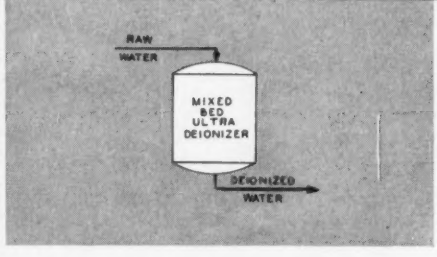




Delivers highest quality deionized water, free from silica and CO_2. Last two columns provide the "polishing" steps.

Delivers deionized water free from silica and CO_2. Usually built in large sizes for low cost CO_2 removal.





Delivers deionized water of highest known quality—free from silica and CO_2. Used alone and as "polishing" unit.

Yes, there is an Elgin ion exchanger that will exactly meet your needs . . .

Some of the modern methods we are using today are diagrammed above . . . and there are many combinations of these dictated by the variables in water supply and final use.

But whether your requirements can be met by a simple zeolite water softener—or whether you need the most highly "polished" water—this much is certain: The best and most economical solution to your problem must come from a firm like Elgin that offers *every* modern and authoritative approach.

Write for the Guide to Better Water Treatment — Bulletin 615

ELGIN SOFTENER CORPORATION

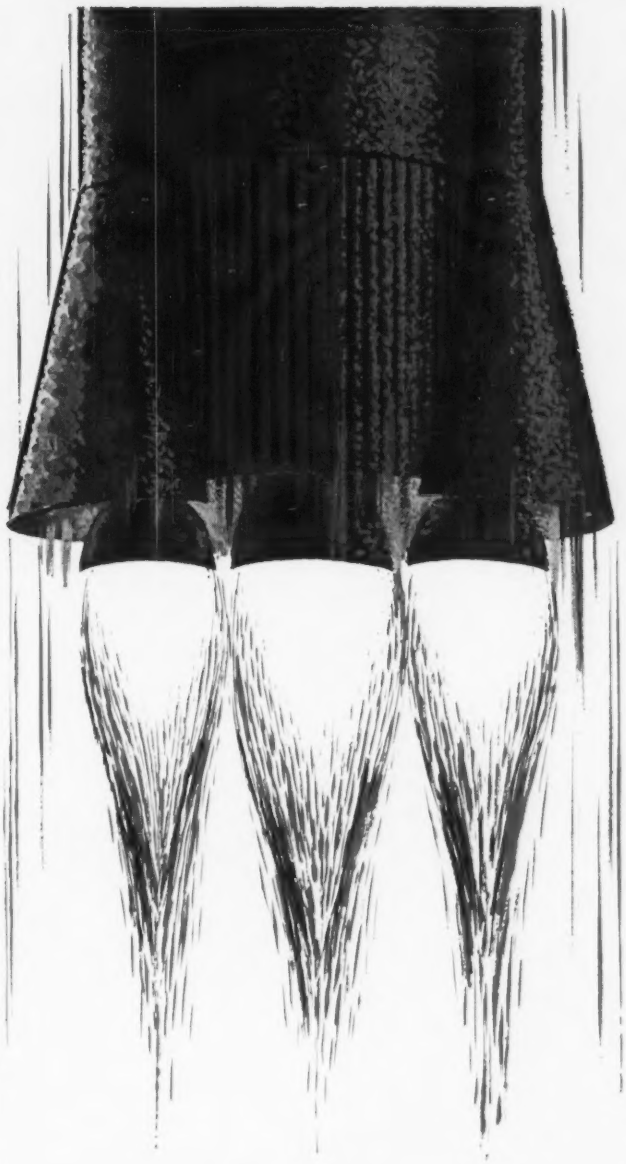
130 North Grove Avenue • Elgin, Illinois

Representatives in Principal Cities • In Canada: G. F. Sterne & Son Ltd., Brantford

ELGIN
WATER CONDITIONING
SINCE 1908

SOFTENERS • ION EXCHANGERS • FILTERS • DEIONIZERS • DEALKALIZERS • CLARIFIERS • DEGASITORS • DEAERATING HEATERS

For more facts circle 235 on Reader Service card, p 101



The race for space

...where gaskets must not fail

The sealing of rocket fuel is an important contribution of Flexitallic Gaskets in man's conquest of space.

For this critical sealing application, it takes the Flexitallic Spiral-Wound Gasket construction — using the proper metal, the proper filler, and the proper yield characteristics determined by Flexitallic engineers.

Every Flexitallic Gasket is designed for the specific job it has to do—the sealing of corrosive fluids, temperatures from extreme sub-zero to maximum temperatures compatible with available metals. Pressures ranging to 15,000 lbs. p.s.i., or temperatures to 2500°F. do not impose impossible limitations. The Flexitallic Gasket construction compensates for unusual joint stress embodied in problems of thermal and physical shock.

Give us the facts about your most serious sealing requirements — in chemical processing, petroleum, power, marine, aircraft and missiles, diesel, or any other field. There's a Flexitallic Gasket to meet your needs — or Flexitallic will design one. Write Flexitallic Gasket Company, Camden 2, New Jersey. Stocking distributors for Standard Flexitallic Gaskets in principal cities.

Flexitallic®
SPIRAL-WOUND GASKETS

For more facts circle 236 on Reader Service card, p 101

TERRIFIC!

— and how long will the flexing member last?

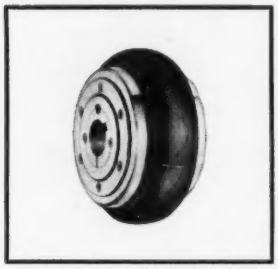
Good question. The heart of Para-flex is a tire with synthetic tension members bonded together in rubber—which provides a flexing body that automatically compensates for *all combinations* of misalignment and end float, and absorbs vibration as well!

This amazing coupling has now been used in American industry 4 years. Thousands are in operation—in steel mills, paper mills, oil fields, mines, quarries, chemical plants, everywhere—and in these 4 years, replacements of elements have been negligible.

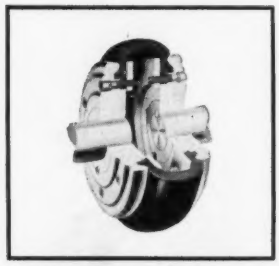
Dodge Standard Para-flex takes angular misalignment up to 4°, parallel misalignment up to ⅛″ and end float up to 5/16″ depending upon the size of the coupling and the duration of shaft displacement.

Dodge Para-flex is available in 3 types—Standard, Flywheel and High Speed (shown at right). The Standard type is stocked in capacities up to 3640 hp at 910 rpm. Ask your Dodge Distributor, or write us for complete technical bulletin.

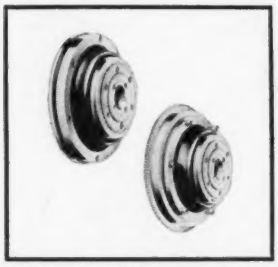
Dodge Manufacturing Corporation, 3200 Union Street, Mishawaka, Indiana



The new idea in flexible cushion couplings, with a flexing member that "swallows up" misalignment.



No lubrication, no maintenance. Replace flexing element without moving driver or driven machine.



Flywheel and High Speed Types. For use with motors and internal combustion engines turning up to 5230 rpm.

The Products with the Pluses . . .

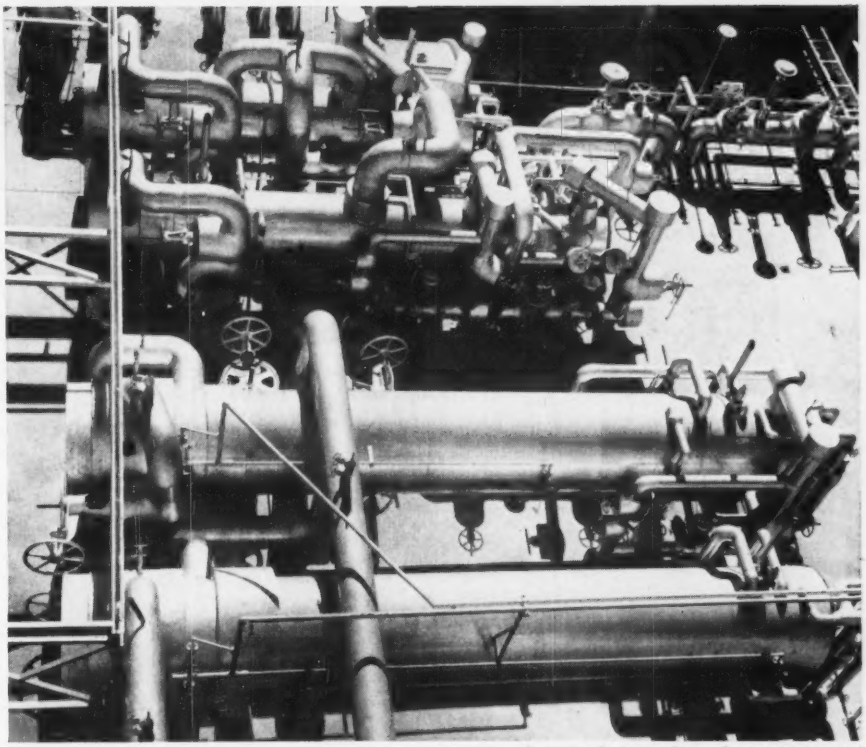
DODGE

of Mishawaka, Ind.

DODGE

Para-flex

CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory trained by Dodge he can give you valuable assistance on new cost-saving methods.



Consulting Engineers: Ebasco Services Incorporated

4,000 PSI 1,000°F (OR EVEN HIGHER WHEN YOU NEED IT!)

FEEDWATER HEATERS WITH YUBA'S EXCLUSIVE MULTILOK CLOSURE are capable in basic design of operating at the extreme pressures and temperatures required more and more by the power industry.

The Multilok Closure, a Yuba exclusive, is one of the important reasons why these units operate so efficiently and safely in the 4,000 PSI, 1,000° F range. And Yuba is prepared to produce units to handle even higher pressures and temperatures when needed. A pioneer in all-welded design, Yuba offers both all-welded and bolted construction – a complete and versatile line of feedwater heaters tor high and low ranges, for every type of job. When space is a critical factor, as many as three low pressure stages can be combined in a single shell for a highly compact unit.

You'll want to discuss both design requirements and costs with Yuba heat transfer engineers during plant planning stages. The scope of Yuba designs will offer the best solution to your particular problem.

Other Yuba products for steam power plants include condensers, evaporators, expansion joints, tanks, bridge and gantry cranes, structural steel erection, and scores of other items.

YUBA

specialists in power plant equipment

YUBA HEAT TRANSFER DIVISION

YUBA CONSOLIDATED INDUSTRIES, INC.

Sales Offices in Principal Cities

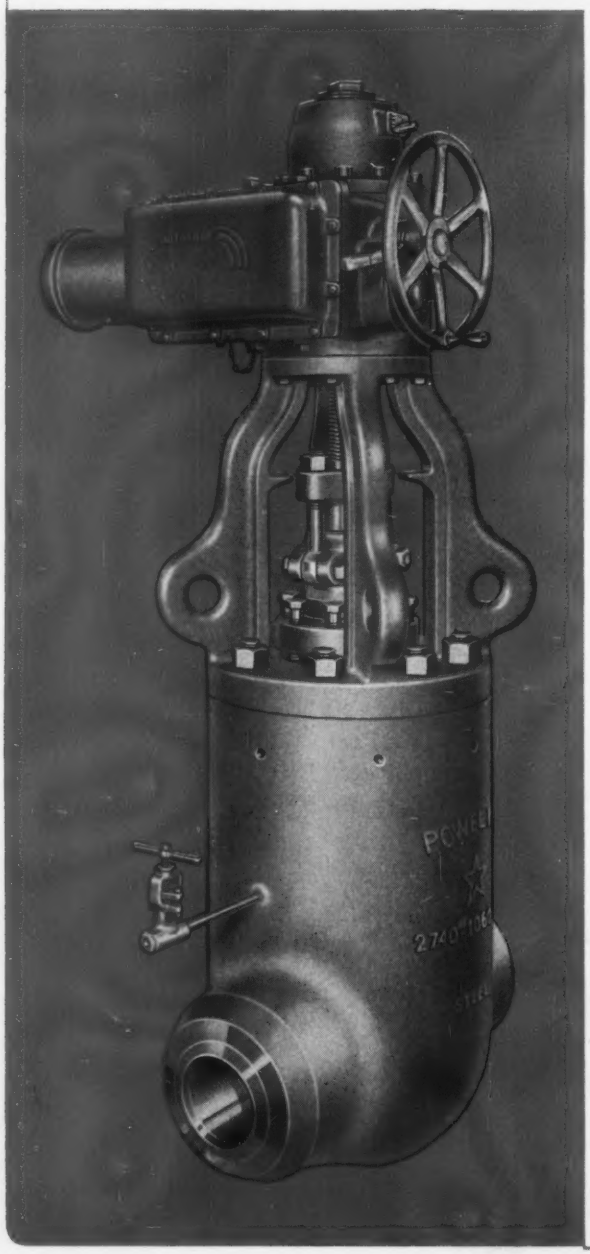
For more facts circle 238 on Reader Service card, p 101

EXTRA POWELL VALVE NEWS

THE WM. POWELL COMPANY CINCINNATI 22, OHIO

115th year of manufacturing industrial valves for the free world

NEW HIGH PRESSURE—HIGH TEMPERATURE VALVE FOR POWER PLANT OPERATION



AT 2740 psig AND 1060° F

Powell proudly presents this new Pressure Seal O.S. & Y. Gate Valve, especially engineered for ultra high pressure-high temperature service in one of the nation's largest modern plants. Its outstanding performance results from many key design features, such as:

- Body, Bonnet and Wedge of Chromium-Molybdeum Steel, according to ASTM specification A-217, Grade WC9.
- Internal working parts constructed of long-wearing materials, proven for uninterrupted service under severe operating conditions. Stellite facings on the wedge and seat rings.
- A Chrome-moly Bleed-off Valve extends through the body and facilitates valve opening by relieving pressure within the valve when it is closed.
- The top mounted weatherproof Electric Motor Operator, for remote control, has a *Spring* that automatically compensates for the changes of contraction or expansion of the valve stem, wedge and body. Proper and precise seating at all times is assured.

Development of this new high pressure-high temperature gate valve is positive evidence of Powell's ability to meet any industrial valve requirement—with regular or special designs—in bronze, iron, steel or alloys—for water, oil, gas, steam, and corrosive service. For further information or assistance, consult your nearby Powell Valve Distributor, or write direct.

For more facts circle 239 on Reader Service card, p 101

LOUIS N ROWLEY, EDITOR • MARCH 1961 • ESTABLISHED 1882 **Power**

Electrical safety: Who is really responsible?

From the very beginning of the electrical industry, safety has been a prime concern. At first, the major consideration was hazard to life and limb. But as equipment has become more complex and systems more extensive, and as standards of service have risen, safety has taken on added dimensions—protection against costly equipment damage and against the economic loss involved in downtime.

By the same token, higher voltages and larger systems with potentially greater fault currents have multiplied the problems of attaining satisfactory levels of safety. Thus it is not surprising that electrical safety remains a "hot" subject, one that engages the best engineering minds among equipment manufacturers, system designers and plant managers. The *Today's Development* report beginning on p 183 of this issue bears testimony to the preoccupation of all three groups with the various aspects of the safety question.

That manufacturers are cognizant of the importance of building greater safety into electrical equipment can be seen in a host of innovations and improvements. The concern of system designers is evidenced in continued exploration of such questions as neutral grounding and the continuing reexamination and strengthening of system-design standards. But it is by no means as clear that plant managers and engineers are sufficiently aware of their responsibilities in this area and are discharging them fully.

Yet the user engineering group is, in my opinion, the most important in continued efforts to raise the levels of electrical safety. The energy-systems engineers of industry must be able to discern added values built into equipment by the manufacturers and to demonstrate to financial management that investment in safety features will pay off in reliable operation. In the same fashion, they must be capable of defending the recommendations of safety-conscious system designers and of resisting the temptation to cut corners when increased hazards may be the real price.

Perhaps most important, the energy-systems engineers of industry must be unceasingly aware of the grim fact that no electrical system is any safer than the people who operate and maintain it. As our in-plant electrical systems have grown ever more sophisticated, have our personnel and methods kept pace? A current study of one phase of this question —maintenance of protective relays—yields strong indications that we have *not* kept pace. Nor is this the only area where there is cause for concern about people and methods.

Here is a job for every engineer responsible for the management of an in-plant electrical system. It demands a searching analysis of the adequacy of present operating and maintenance procedures, plus a hard look at the skills and knowledge of the men charged with carrying them out. And almost surely it calls for intensified training and education to make the people as good as the system and the equipment they must safely operate and maintain.

For 99 out of 100...

Selection of

can be as simple as selection of Bronze and Iron Valves

HOW to keep it simple? Don't let the wide selection of stainless steel alloys "throw you"!

Most of the alloy specs were developed to meet certain highly specialized and rather uncommon needs. Only 1 out of 100 valve users can make practical use of many of the alloys. *Actually, just two or three of the different available alloys will give a big majority of valve users all they want and need.*

You can judge DESIGN differences between the various "makes" exactly as you do it with Bronze and Iron valves. Look them over and compare. Basically, of course, a Stainless Steel valve is designed and constructed very much like other valves.

What is left to worry about in addition to Material and Design? The same factors you consider in buying ANY valves for long, dependable performance: Are the valves made merely good enough, or to a standard that demands an extra-measure of quality? How good are the castings? How precise and perfect is the machining? How rigid is the inspection and testing during manufacture? These are the factors which specs can't cover. Some of them you can't see when you look at the valve. But you KNOW how to make sure they measure-up to peak standards. You know that the name JENKINS VALVES and the famous Jenkins DIAMOND trademark have been the highest assurance of quality for nearly a century.

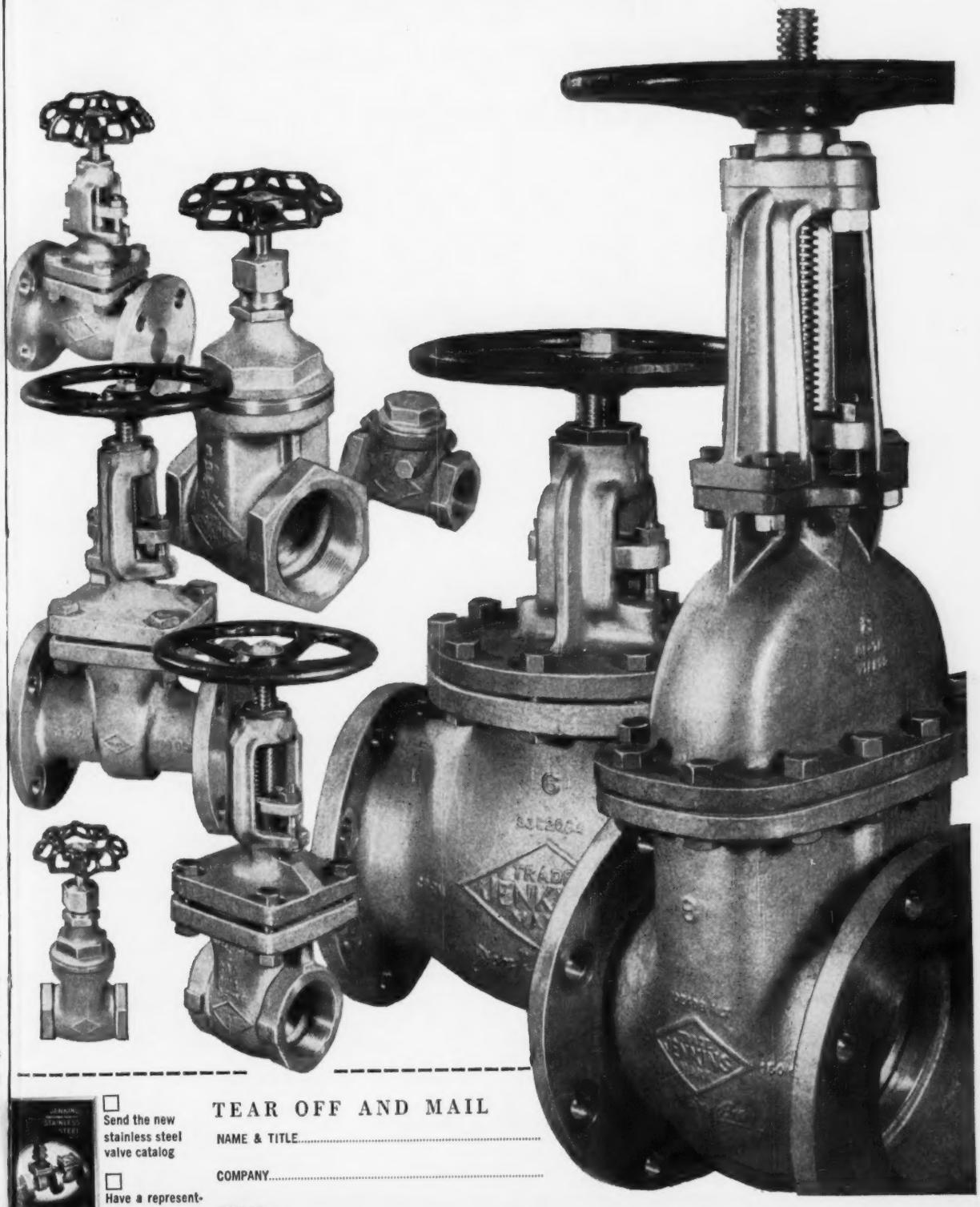
Specify *"Jenkins"* as well as the metal alloy to assure fullest satisfaction. Your Jenkins Distributor has patterns and alloys to satisfy most industrial needs. Of course, they meet valve industry specifications and the high standards established by leading users of stainless steel valves. Jenkins Bros., 100 Park Ave., New York 17.

JENKINS VALVES

JENKINS SINCE 1864

Jenkins Bros

Stainless Steel Valves



☐ Send the new stainless steel valve catalog

☐ Have a representative call on me

TEAR OFF AND MAIL

NAME & TITLE.....

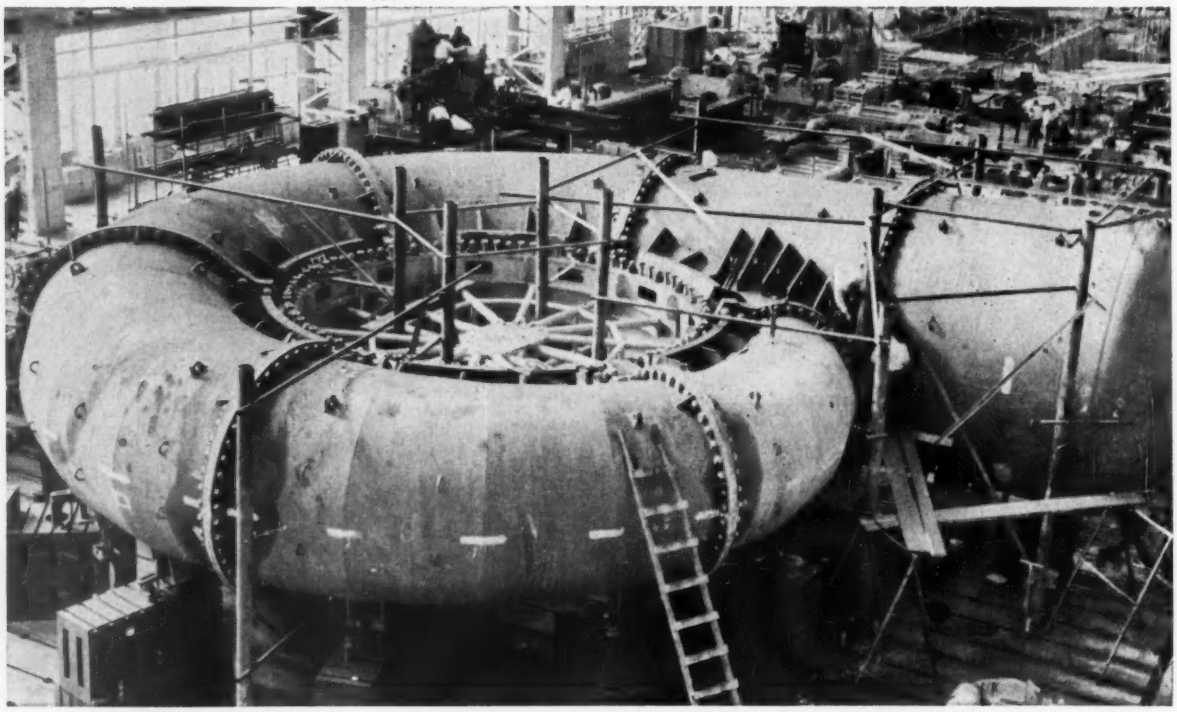
COMPANY.....

ADDRESS.....

For more facts circle 240 on Reader Service card, p 101

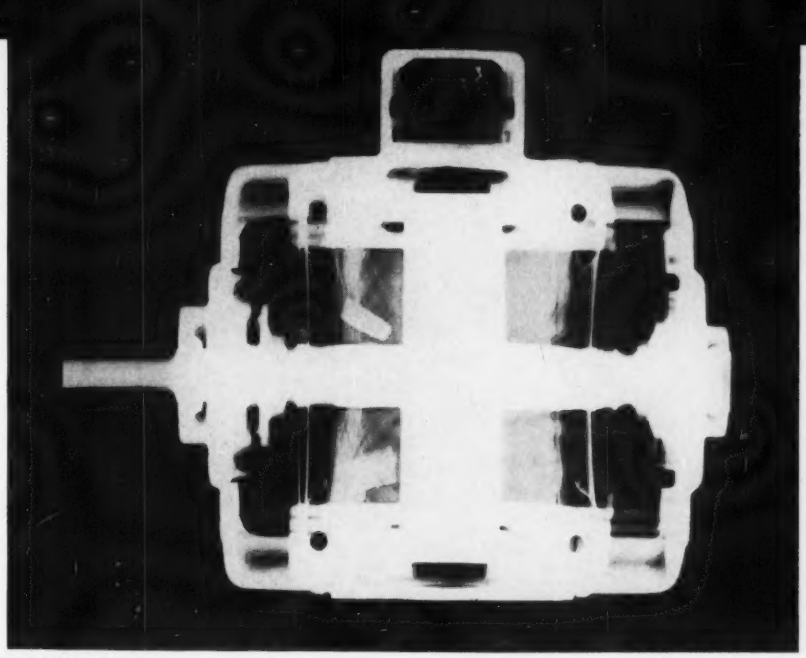
HITACHI

now completing the first hydraulic turbines for Thailand's Yanhee Project



Shop tests were recently completed on the spiral casing for the first of two 115,000 HP Francis-type turbines being completed by Hitachi for Thailand's Royal Irrigation Department. These will be the first of the planned 8 sets of generating units to be installed at the downstream of the Bhumiphol Dam, as part of the Yanhee Multipurpose Project which will commence operation in 1963 and eventually supply 560,000 kW of power to Bangkok and Thonburi. The vertical shaft Francis turbines have been designed to deliver 115,000 HP under the effective head of 112 m and for a speed of 150 rpm. Their spiral casings, with inlet diameter of 4150mm, will each be divided into 7 sections for transportation by barge up the Ping River to the site.

Hitachi, Ltd.
Tokyo, Japan
Cable Address: "HITACHY" TOKYO



THERMAL SENSORS are imbedded in motor winding to detect actual overload temperature

What are advantages of overtemperature protection today? Will it replace established overcurrent protection? Here is evidence of a better job when you . . .

Protect your motors with temperature-sensing devices

By W J MARTINY
General Electric Co

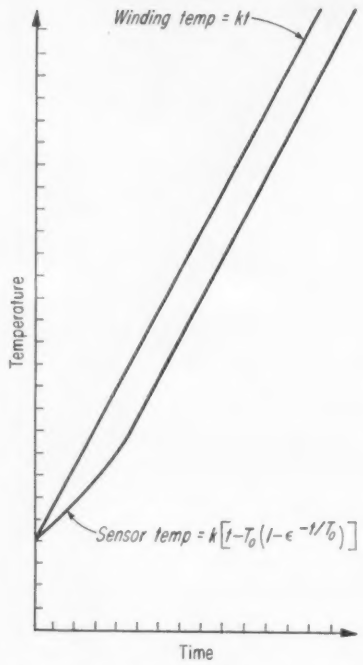
Temperature can serve as a basis for motor protection. Traditionally, motor protection starts with line current, as does short-circuit protection. But thermal protection is more complete, more accurate. Overcurrent is a common cause of overtemperature, but it's the overtemperature itself which does the damage. (This excludes extra damage caused by fault current after initial dielectric breakdown.)

At the time standards for motor overload protection were being developed, temperature-sensing devices were large and open. They could not be located close to motor windings. But new ideas in devices and sealing methods make it possible to locate sensing devices entirely within the winding. A late design is shown above.

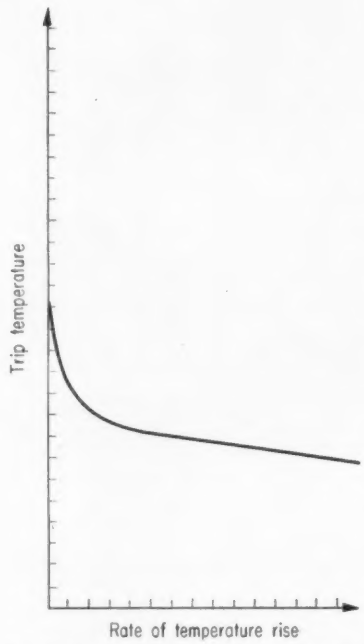
Proper device properly located provides overtemperature protection for failure to start, loss of ventilation and many other causes besides overload. Test data, p 61, gives trip time and temperatures for typical commercial motors protected by purely thermal devices. As data shows, present-day general-purpose motors can be adequately protected. Response also seems sufficient for special-purpose motor designs as well as anticipated future designs.

Every effort was made to get accurate temperature readings during tests. A combination of methods was used. Thermocouples were imbedded in winding to get measurements of "in-the-stack" temperatures. A thermocouple was brazed to end-turn wire to test minimum thermal lag on rapid rates of rise. In addition, shutdown resistance was taken and the curves extrapolated back to "power-off" time to come up with resistance-caused rise. No special effort was made to determine rotor temperatures—these are not limiting on ratings shown. Calculated and approximate values as determined by change in slip under constant load were close enough in agreement, so no slip rings or other equipment were installed.

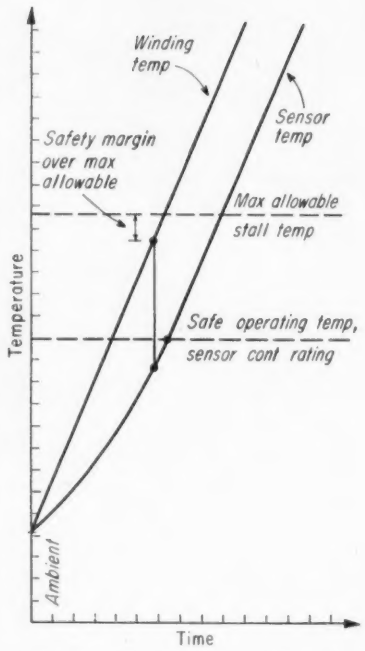
Many motors need no special care to avoid rotor damage. These include most units below 200 hp. Rotor protection is available in some cases—of small ac motors with



1 Sensor lags winding by kT_o. T_o = delay time constant, k = rate of rise



2 Anticipation characteristic shows effect of rate of rise on the trip temperature



3 Standard motor is protected from fast temperature rises by anticipation feature

"thermal protection" built so far by General Electric, 10 to 15% are rotor-limited. But this is a special problem.

Motor designer must, of course, accept responsibility for protecting all parts of his motor, not just the stator winding. If the system can't do it, motor should not be identified as thermally protected.

Thermal protection is more-complete protection because it covers all causes of overtemperature, not simply overcurrent. If motor locations are inadequately ventilated, motor heat raises inlet-air and motor-winding temperatures. Lint, dust, chips or snow blocking inlet or discharge reduce motor ventilation. Temperature rise can easily be two or three times normal; immediate burnout results or life is cut, even when motor runs at less than normal load.

Operation at less than normal speed (jogging, or when repeated reversals are part of operating cycle) increases temperature, though rms current is even less than normal. Motors operating at below-normal frequency or adjustable-speed motors at subnormal speeds represent a similar situation.

Unbalanced or single-phase currents affect temperature rise differently than balanced currents of equal magnitude. In tests at 135% of rated current, single phase produced an average temperature rise 20% higher than the same balanced current; rotor rise was 30% higher.

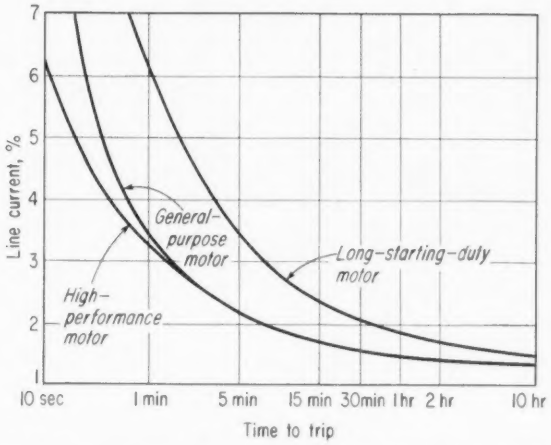
Higher-than-normal voltage or lower-than-normal frequency at normal voltage induces higher flux densities in motor field. These give higher core losses. In most induction motors slightly higher voltage has small effect on loss, but with higher-performance machines or very large increases in voltage, temperature increases significantly at a given current level. Example: core loss may increase 40% for a 10% voltage increase; at 25% overvoltage, loss would increase by 200%, causing much-higher operating temperature without exceeding normal current.

Installation of temperature-sensitive element must be carefully controlled. With locked rotor or heavy overload a temperature rise as high as 7 C per sec is quite common. Motor windings would reach 180 C from cold start at 40 C in only 20 sec. Usual thermostats applied to outside of winding will not respond to this transient rise fast enough to protect the motor. With overload and other situations where excessive temperature is reached at slower rate, winding temperature must be measured accurately. For this and other practical reasons, thermal protectors should be installed at factory or by competent service personnel.

Hot-spot temperature should be located and measured if possible—but this is not absolutely essential. Hot-spot temperature usually moves about as loading conditions change. Under steady heavy load, hot spot is more likely to occur at stack center; during stall the end turn is most likely to be hottest. It's very desirable to sense temperature of most critical spot, but you can protect by sensing a somewhat less-sensitive position. Very effective rotor protection can be supplied on some wound-rotor motors by sensing stator temperature.

Response of thermal protectors is excellent. Foremost problem: getting good thermal contact. Since protector must be electrically insulated from the conductor, protector temperature will lag that of conductor, Fig. 1. Reducing sensor mass or decreasing thermal resistance cuts delay. When sensor element is a thin-wall tube, low ratio of mass to contact area gives very low delay. Compensating for thermal lag further improves response.

Tests show how thermally protected motors perform



4 Different motor designs and applications require various protector characteristics for adequate winding protection

Test condition	Time to trip	Time to reset	Maximum temperature
Test motor 1			
90% voltage, 115% output, 40-C ambient, 132% current	continuous without trip		
100% voltage, 30-C ambient, 171% current	19.2 min	2.8 min	105 C
100% voltage, 1 phase, 30-C ambient, 207% current	8.1 min	0.8 min	103 C
100% voltage, locked rotor, 30-C ambient, 560% current	23 sec	75 sec	122 C
163% voltage, locked rotor, 30-C ambient, 1030% current	7.8 sec	140 sec	148 C
100% voltage, 1 phase, locked rotor, 30-C ambient, 460% current	26 sec	51 sec	101 C
Test motor 2			
100% voltage, 25-C ambient, 145% current	continuous without trip		
100% voltage, 25-C ambient, 175% current	21.4 min	0.8 min	123 C
100% voltage, locked rotor, 25-C ambient, 535% current	24 sec	60 sec	112 C
100% voltage, 1 phase, locked rotor, 25-C ambient, 422% current	40 sec	96 sec	111 C

Test motor 1—NEMA design B, frame 284, 15 hp, 1800 rpm, 220/440 v, 3 phase, 60 cps, 40-C rise, 1.15 service factor, 38.6/19.3 full-load amp
Test motor 2—NEMA design B, frame 326, 40 hp, 3600 rpm, 550 v, 3 phase, 60 cps, 40-C rise, 1.15 service factor, 38.9 full-load amp

Compensation is easily achieved using concentric elements, each with positive coefficients of expansion, Fig. 2. Besides protecting better on high rates of rise by reducing thermal overshoot, the anticipation characteristic reduces reset time. Other means are effective, too—details of several thermal protectors are discussed in *Product Engineering*, Sept 12, 1960, pp 53 to 61.

Protector mass plus electrical insulation form thermal equivalent of a series RC circuit. Its response to a linear-winding temperature rise is shown in Fig. 1. This is a locked-rotor or heavy-overload condition. Rate of rise is nearly linear up to limiting temperatures. During initial period of a stall or heavy overload the extra losses are nearly all stored in winding. After winding temperature rises appreciably above ambient, a leveling off occurs according to the exponential curve of a simple parallel RC circuit (see the sensor-temperature equation, Fig. 1).

To offset this delay and prevent severe overshoot, a device was designed with a trip temperature biased by its own rate of temperature rise, Fig. 2. When device is applied to a winding with a high rate of rise, Fig. 3, the trip prevents severe overshoot. But under light overloads normal trip temperature is permitted.

Greater accuracy is another advantage of thermal protection. Overcurrent devices frequently use thermal elements for time delay. Inherent accuracy of thermal-protective devices is therefore at least equivalent to those for overcurrent protection. Overcurrent protection, however, necessitates relating motor temperature to current. For large machines or where dollar value of individual installation warrants, a specific design study can coordinate relay with motor. Even then it may be difficult.

The way small motors are usually sold makes this type of handling impractical. Instead, rules of practice have been developed to which both motor and control manufacturers must adhere. Commonly sold relays have certain time-temperature characteristics and are applied by NEC prescription or by some other acceptable practice. Control designer must assume that every motor operates at full temperature rise at nameplate current since he can't tell which motors contain extra thermal margin. Manufacturer, on the other hand, must design his motors so none exceed full temperature rise. Full variation between ratings must be extra thermal margin, built into the motor.

Since motor loads and voltage supply are not constant, users have learned that this extra margin can be relied on to carry motors through peak-load periods. But trusting

Connect thermal protectors for manual or automatic restart

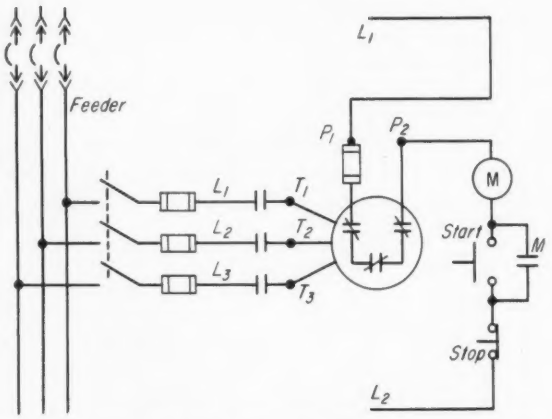
indiscriminately in "margin" leads to greatly exceeding normal motor temperature. Result: immediate failure or reduced life span. Thermal protectors work at a safe level. No unnecessary risk is involved in using motor's full capacity.

Overcurrent relays introduce another tolerance; they usually have 10% intervals between ratings. Location of motor full-load current within relay band partly determines overload but is totally unrelated to thermal capacity.

Tolerances so far discussed seem reasonable enough, but they can combine to produce startling results. Consider two extreme cases. First, a general-purpose motor's maximum temperature rise is 50 C by resistance (40 C by thermometer) and full-load current at bottom of overload relay's range. This relay then permits 125% nameplate current in 40-C ambient, or 78-C rise and 118-C total. Another motor runs only 40 C by resistance and is at top of relay band. This motor would have a 53-C rise at trip current or 93-C total temperature at the 115% current allowed. It is also possible for second motor to be ordered with screens or splashproof enclosures which may add as little as 5 C to rated-load temperature rise—but reduce current for selecting overload protection by 10%. In this instance, relay permits only 104% current and motor will have only a 48-C rise or 88-C total at trip current.

With these perfectly standard applications it is possible to have a 30-C difference in motor temperature at trip time—60% of normal rise. If the next size heater is used with the first motor it will permit 138% current and 135-C total temperature when relay trips. Modern Class-A insulation systems give several thousand hours' life at this temperature. So, since this peak will only be reached during periods of high ambient, low voltage or other unusual conditions, you can expect long life if nuisance tripping does not persist. Present practices are adequate and tolerances should not cause trouble. Nevertheless, the practice does involve a 47-C tolerance in protection level, nearly equal to total temperature rise permitted for Class-A insulation. Thermal protectors will eliminate many of the factors contributing to the tolerance and reduce it to a maximum of 10 or 15 C.

Special motors or unusual applications need different characteristic curves as well as different current levels for overcurrent relays, Fig. 4. Motors for high-inertia drives have longer stall times but not necessarily higher continuous overload capacity. This service needs a new family of curves with slower trips under high current but normal continuous currents. Hermetic-refrigeration motors need quicker trips at inrush current but normal continuous currents. These and many other problems require special knowledge of the motor to relate current to temperature. Data in this region is scarce but applying thermal protectors is simple since they are designed for the insulation system plus a small margin for disturbances.



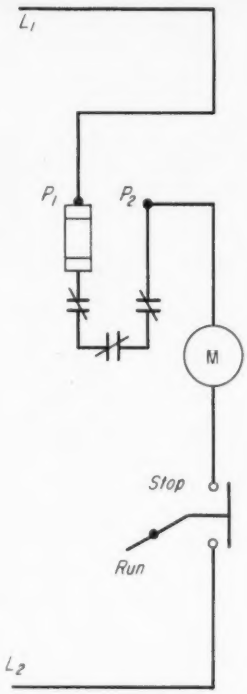
5 Typical connection for thermally protected motor provides automatic reset after an overload with manual start and restart

Setting of a thermal protector must be high enough to permit full motor loading without nuisance tripping during periods of high ambient or low voltage. To handle this service, setting must be above insulation-class design value. Conditions will very seldom be so uniform that continuous loading up to maximum is possible without frequent trips. So you should expect normal life on any application which does not repeatedly trip; when repeated trips occur, expect something less than normal.

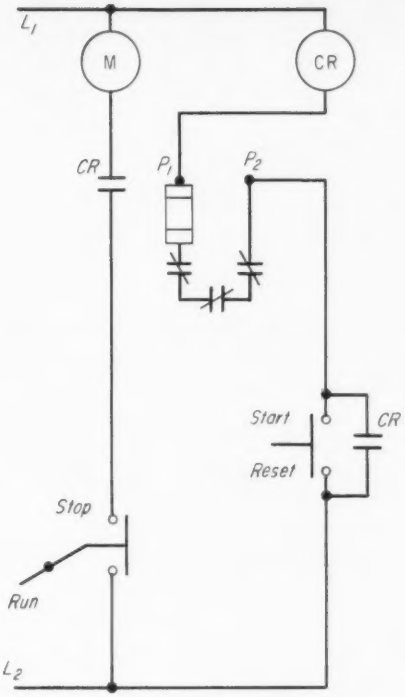
Practices and standards developed during the many years of overcurrent protection will see some change with the advent of thermal protection. A protector located in the starter is easily replaced by a shop electrician. In the motor winding, it must outlast the winding. On the other side of the coin, thermal protectors are not readily accessible so they will not be subject to direct mechanical abuse. Shock and vibration will be transmitted through motor to device; accelerations on the order of 10 g must be expected. Device shown on first page will not chatter at this level, but may trip 2 or 3 C below unagitated trip value. Higher values of shock may cause device to operate, but before permanent damage occurs, shock forces will have to be great enough to damage the motor, too.

Development samples were evaluated at temperature extremes—little effect on functioning. They were plunged to –40 C, thrust into an oven at 225 C to evaluate effect of thermal shock. Since device is hermetically sealed, long contact life is expected. All exposed surfaces are either stainless steel or ceramic material. Life tests at rated load showed little calibration change in 120,000 operations.

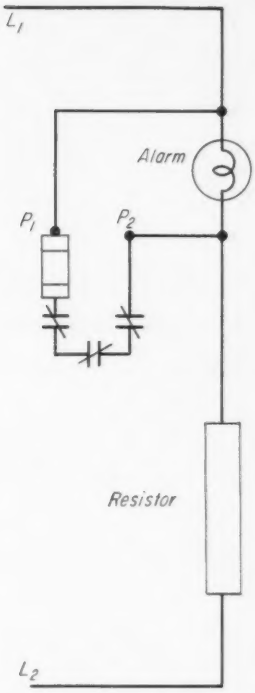
Excessive current may damage contacts, so the control



6 Automatic restart after overload depends on a maintained-contact start



7 Lockout on overload works by using an auxiliary relay and start-reset button



8 Alarm circuit can be used. It signals too-hot winding, resets when cool

circuit is fused. Fuse is presently supplied with every motor, mounted in one of protector's leads.

Resetting overload relays is usually manual. Thermal protectors reset automatically—but this does not necessitate automatic restart. Several circuits are possible, Fig. 5 to 8. Fig. 5 shows simplest scheme—trip on overload with manual restart. Others shown are automatic restart, Fig. 6; manual reset with separate relay, Fig. 7; signals on overload, Fig. 8.

One protector is used per phase on all 3-phase motors for single-phase protection, including loss of a primary phase on wye-delta systems. An extra set of protectors could be used for signals—for example, when it is safe to begin an acceleration or when load must be reduced to avoid a trip. 2-winding motors will need a protector in each winding. They will be properly located on first step of wye-delta or part-winding starters.

Branch-circuit elements are commonly protected by same device used for motor overload. This practice need not change with thermal protection. In fact, the words "thermal protection" have come to mean complete protection by virtue of NEC.

We have discussed factors which make overcurrent protection insufficient to guard motor from overtemperature. Factors which make overtemperature protection insufficient for branch-circuit overcurrent protection are somewhat different but generally predictable. For one thing, motor designer can figure, under normal conditions, what current will trigger protector. But "normal" conditions are usually ideal conditions; a departure from these such as unbalanced voltage or blocked ventilation reduces current required to reach trip temperature of the protector.

When motor is designed, branch-circuit elements specified by NEC can be assumed unless special conditions are known to exist. With these branch-circuit elements and the known protection level it is possible for the motor designer to determine protection adequacy. If inadequate, designer can correct the situation or warn user by omitting the words "thermal protection" in connection with the motor. In most cases no problem will exist—motor and supply capacity should be matched for balanced design.

Some situations may require separate branch-circuit protection. Motors which operate in a special ambient may not respond to conductor ambient and, therefore, permit circuit overloading. These conditions can be readily determined by equipment designer or installation supervisor. Thermal protectors for refrigeration-compressor equipment may or may not provide adequate branch-circuit protection. This system can be analyzed easily by compressor and motor manufacturers jointly, and extra protection prescribed when they decide that it's needed.

In general-purpose installations where motor is known to operate in a much lower ambient than conductors, the electrical contractor will have to provide a remedy—much as he does at present when conductor and starter are in different ambients. He can use a larger conductor or provide separate protection in conductor ambient.

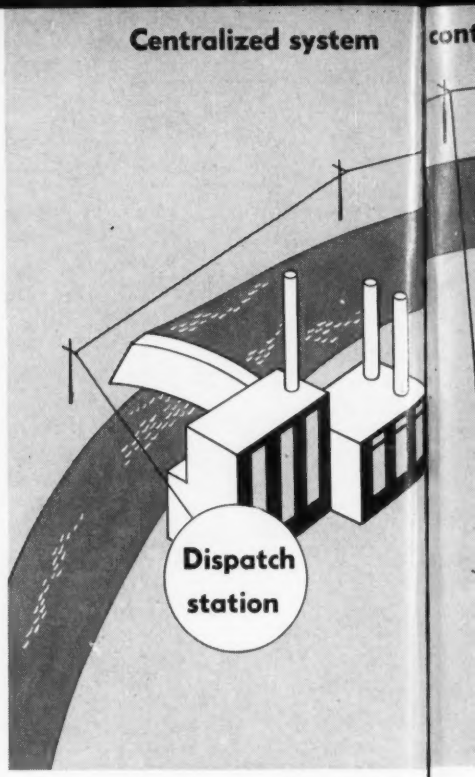
Motor circuits are unique in that overload protection is separate from fault protection. Fault protection must be located at supply end of circuit regardless of overload device being used. For circuits using thermal overload protection this practice will not change.

SUPERVISORY CONTROL—part 3

Let's look into a practical example of designing and applying systems for supervisory control. Following step-by-step design of one system, we'll see . . .

How to build up complete supervisory control for your plant

By H BERNSTEIN, Section Head, Centralized Operations Control
Hammarlund Automation Div, Telechrome Manufacturing Corp



More and more, energy-systems engineers have to lay out specifications for remote supervisory-control systems to be finally manufactured by a systems vendor. First and second articles in this series (POWER, Aug '59, pp 68-70 and April '60, pp 102-104) described basic principles of the various types of supervisory control. Now, let's see how these principles may be applied to the job of specifying a plant system. We will describe the step-by-step procedure involved in setting up specifications for an entire supervisory-control system. In addition, by following through to selection of system components, we will trace the effect of our original specifications on the final system design.

Our sample system will be designed to handle the needs of a modern, self-contained paper mill which owns and operates two hydroelectric power plants some distance from the main plant. Diagram above shows relative layout. Power from these hydro stations feeds a plant system which also includes several steam-turbine-generator units at the main mill.

As an aid in integrating all power sources, paper-mill operator is to control operation of the two remote hydro plants. Power plants at Far River and Willow Dams each contain two water gates and two hydroelectric generators and are associated with a reservior at each dam. All components are to be placed under remote supervisory control.

First step in planning a supervisory-control system is listing the points to be controlled and supervised. In most cases this is not difficult since you are merely moving the control point from the local panel to some remote master. Exceptions may occur when processes previously operated manually are to be controlled from a remote location. Then you must select important control parameters and required operating data, leaning on your knowledge of the process.

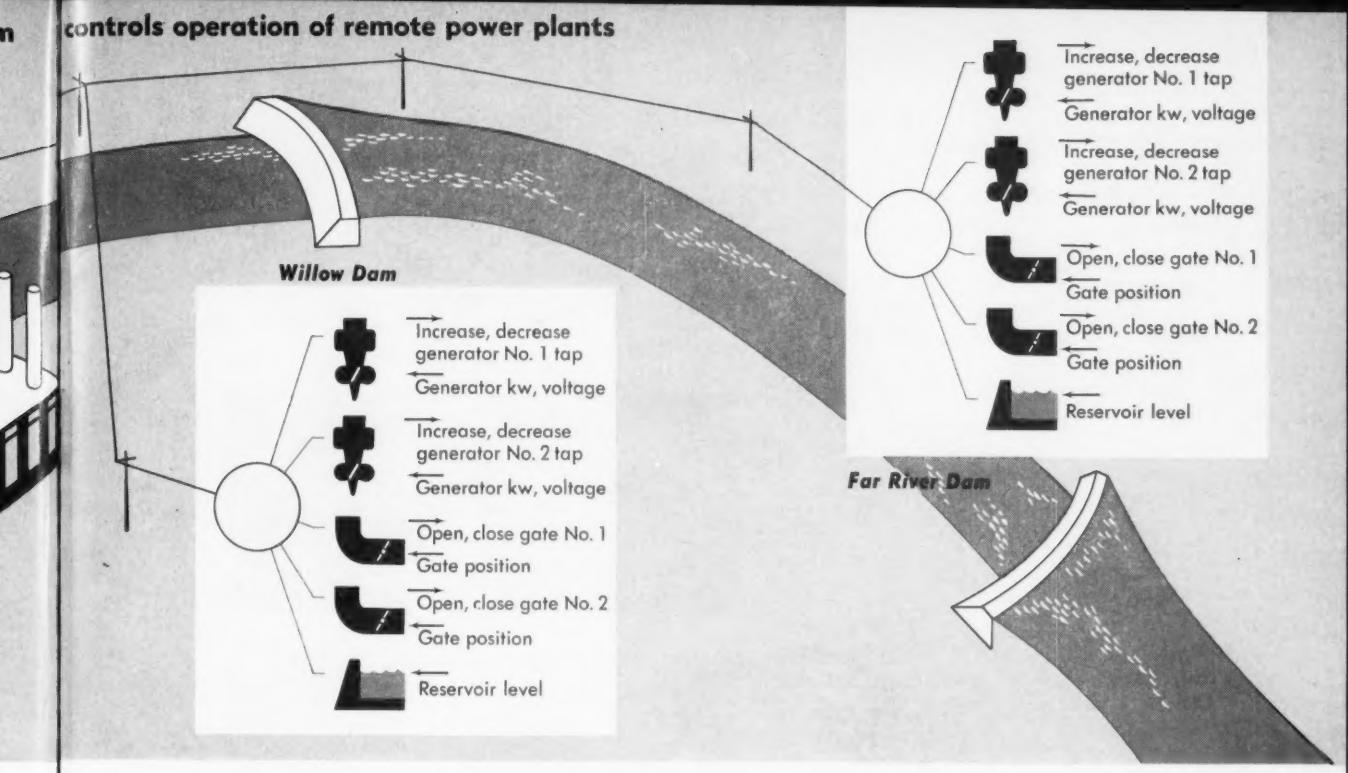
If we list requirements for the two hydro plants we find each of the water gates is to be operated from the dispatch station, and gate position is to be supervised. Tap position of the generators will be controlled from the paper mill, with power, generator output voltage and reservoir level telemetered to the paper mill.

Control points must be analyzed carefully to determine degree of control required and most-desirable method. Should the device be operated upon immediately when the operator presses the button? Or should operator get a report-back of point selected before operation begins? Should control be proportional?

In direct-operate control the operator presses either an "on" or an "off" button. This sends a command signal to a remote station, which causes the device controlled to assume the new state. In select-before-operate control, the operator presses a "select" button for the point he is interested in. A selection command goes out to the remote station. There, a selection relay latches in and the operator receives a report-back of point selected. When he's sure the point is right, he sends the "on" or "off" command to the remote station.

For proportioning control, as in positioning a valve gate, the operator can "open" or "close" a device as long as the controlling button is depressed. Obviously this kind of control must be accompanied by supervisory equipment to indicate position of the controlled device.

Supervision generally is of several types: supervision of alarm or emergency conditions, supervision of devices which are either "on" or



"off," supervision of variable quantities such as pressure or the valve gate we mentioned.

Total number of points to be controlled or supervised usually determines the general type of supervisory system we select. For three or four points between one dispatch station and one remote station, one audio frequency channel usually is assigned to each point of control or supervision. As the number of points increases, more-complex coding may be required to handle the job.

Communication channels to be used may be selected on the basis of layout between remote stations and the dispatch station, as well as availability of communication media between the stations. Telephone lines predominate, but microwave and power-line carriers also are frequent.

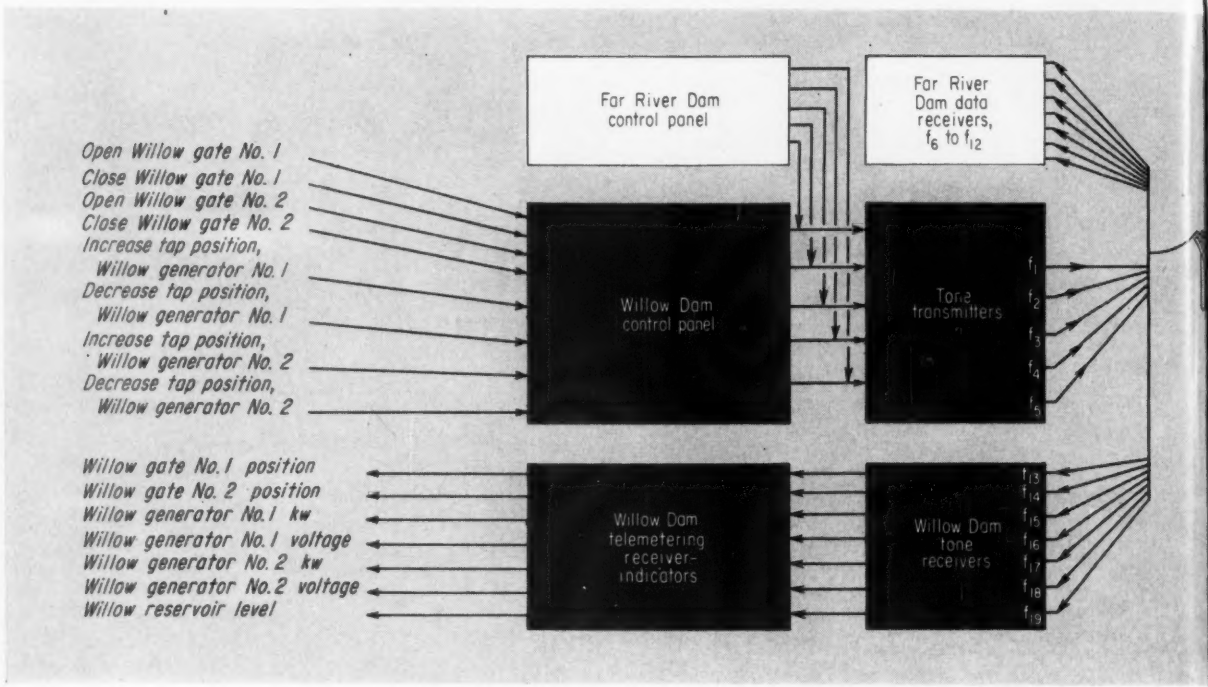
Telephone lines of the average voice grade probably are the most readily available medium. They will accept 23 audio frequencies—for details see Parts I and II. Number of telephone lines available for the system under consideration will also determine type of supervisory control. Since you will want to keep down both the initial cost of the system and the lease rate of rented telephone lines, items must be considered jointly so overall owning and operating cost is minimized. For instance, if you find that all the remote stations are located fairly close to one another, and the terrain permits, it would be most economical for the telephone company to string a common line linking all the stations. This would use a maximum number of frequencies on one line, keeping down leased rate per mile for the system communication channel.

We'll pick a telephone-line channel for our system since terrain is favorable and telephone communication would be available. It is feasible to bring one single telephone line from the farthest station to the paper mill and bridge across the line at the intermediate station. Or we could carry individual lines radially from each of the two remote stations to the dispatch station. In this case the total number of control points is 16, and the total number of supervision points, 14.

If individual tone channels were used, a total of 30 channels would be required, 7 frequencies greater than the normal telephone-line spectrum. So we'd need two separate phone lines. Therefore, instead of a simplex system we'll use coding, decreasing the total number of channels and permitting a single telephone line.

Location of each station and approximate layout along the communication line is shown above. Listed on the diagram: control and supervision requirements of the two plants. If we examine system supervision and control requirements we find that supervision should be continuous, and an analog quantity, for each of the items shown. Therefore 14 individual tone channels will be assigned to these telemetered points, since coded tones would introduce ambiguity between quantities sharing the same frequencies. Magnitude of the quantity will be determined by using an impulse-duration transducer to key the tone-channel transmitter. Length of impulse is proportional to the analog quantity and we'll use continuous sampling of all data points.

Control is direct-operate and proportional. Opening or closing the water gates or movement of generator tap position is maintained as long as the dispatcher presses a corresponding button at the paper mill. Since only one command at a time will be sent out from the mill we can use coded frequencies without ambiguity



Final layout of supervisory-control system evolves from control

Equipment diagram is drawn up after listing control and data points along left and right margins respectively. Complete control and supervision systems for Willow Dam network appear above. All specific hardware for Far River Dam duplicates units at Willow.

occurring between points sharing common frequencies. Number of codes available in frequency coding is 2^n-1. So 2 frequencies will yield 3 codes, 3 frequencies 7 codes, 4 frequencies 15 codes, 5 frequencies 31 codes, and so on. Since 16 points of control are required, 5 channels will be assigned to control. Available for future expansion within those 5 channels will be 15 codes.

Previously, 14 channels were assigned to supervision for a total utilization of 19. Subtracting 19 from the telephone-line spectrum of 23, we have 4 channels available to expand supervision at a later date.

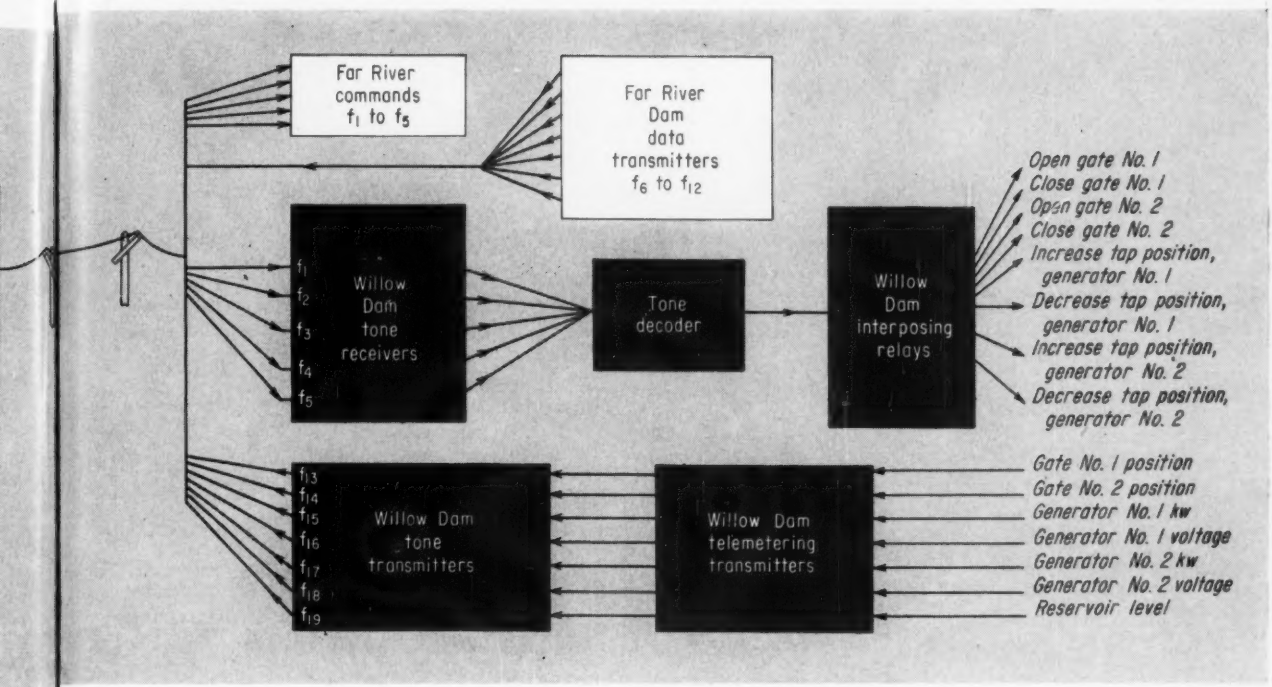
Equipment requirements may be planned in the same way our basic system requirements were arranged on the previous pages. We prepare a diagram of the type shown above, proceed to evolve the component specifications on the basis of signal flow. That is, control signals begin at the dispatching station and follow through to the remote unit; supervisory signals initiate at remote station and are traced through to dispatching station.

Control points enumerated on the left edge of the diagram are grouped separately for Willow and Far River stations. At the mill, control panels are separately assigned for each of the plants; they normally simulate the local control panels at the hydro plants. For ease of maintenance we select sealed switches with an spst momentary contact for each point of control command.

Coding uses back-to-back diodes within the control panel. These channel the closure to the combination of tone transmitters assigned to that particular point. The five common command-tone transmitters at frequencies f_1 through f_5 are drawn next and connected to the telephone line. Five receivers at Far River and five at Willow are assigned to command reception, both sets on frequencies f_1 through f_5. Receiver output closures are connected to a tone decoder. That, in turn, applies a unique closure—according to the code received—to the interposing relay assembly. This is the last item in the channel for the gate or tap controls.

Supervisory channels are prepared in reverse order. Quantities under supervision are indicated along the right margin of the diagram. Telemetering transducers and keyers are next selected. These convert the quantity under measurement to closures for keying the supervisory-tone transmitters shown in the diagram—F_6 through F_{12} for Far River, and F_{13} through F_{19} for Willow station.

Supervisory-tone transmitters connect to the common telephone line. At the paper mill, tone receivers F_6 through F_{12} are assigned to Far River station supervision and F_{13} through



and data-transmission needs plus selection of communication type

Only variations: frequency of tuned channels and tone-decoder circuitry requirements. Actual equipment consists of individual tone receivers and transmitters for each frequency, mounted in racks as a series of building blocks to form unique system

F_{19} to Willow station supervision. Receiver output closures key the telemetering receiver-indicators, which convert the receiver closures into directly displayed analog quantities. These display units are physically located in two groups surrounding the Far River and Willow control panels at the mill dispatch station.

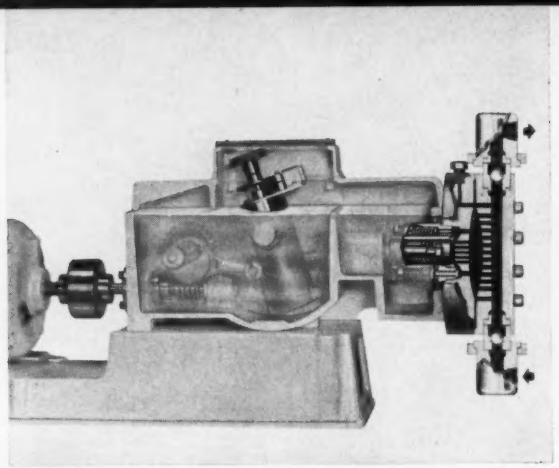
Step-by-step procedures, as listed here, build up to the complete supervisory system best suited to your individual plant requirements. Now that the basic design is completed, let's stop and examine some important decisions you would have to make and their effect on the ultimate use of supervisory control in your plant or series of plants.

Final control system described above represents a typical example of control and supervision of remote-station operation. In this case we have taken the first step toward full plant automation. But, we assume that operating crews will still handle the majority of functions at Far River and Willow. With the planned system, one dispatch engineer at the mill may assign load to any part of his generating system, and will be kept informed of important operating conditions which affect load-dispatching decisions. This fulfills the current requirements of our supervisory-control system for load control.

However, by completely analyzing the plant's generating system, we can foresee the day when unattended operation of Far River and Willow plants may become feasible. At that time additional supervisory information plus additional control commands must be handled by our supervisory control. Selection of coded frequencies for our original system will pay off again when we start to design for unattended operation—15 codes will be available for additional commands of start-stop, switchgear control and other functions of automatic start or stop, safety monitoring.

Additional supervisory points would fall in the category of data on startup conditions, equipment failure or dangerous operation. All these items fall in the category of noncontinuous readings. So the four unused supervisory channels would be able to handle our expanded requirements for data transmission.

System analysis with an eye to current and possible future supervisory-control requirements of our paper-mill example resulted in a basic system at minimum owning and operating cost during the first phase of operation. When later expansion becomes feasible, additional equipment at Far River and Willow stations plus some expanded panel area at the dispatch station will permit unattended operation. At the same time, no original components become superfluous to the final system.



OIL IMMERSION lubricates all working parts. Integral vent and fill valves assure constant oil supply to reciprocating meter pump

Is your chemical feed toxic? hazardous? expensive? Then your feed pumps must meet two needs: controlled volume, no leaks. Find out how . . .

Piston-diaphragm pumps cut

Recent water-treatment developments have introduced many new chemicals. They can be toxic, hazardous and sometimes quite expensive—characteristics which can lead to severe pumping problems. And some old standbys—acid and caustic—are also hard to handle. So from the angles of safety and expense, stuffing-box leakage cannot be tolerated. The usual metering pump is a reciprocating type with extremely high volumetric efficiency. Stroke count serves to meter flow—but these pumps must have a stuffing box. Leakage here may affect metering ability. Where dangerous chemicals are involved, personnel and other hazards are high, housekeeping problems aggravated.

Diaphragm pumps, very much like the ordinary gasoline pump in your automobile, have been used to solve this leakage problem. But this can bring up an out-of-the-frying-pan-into-the-fire situation—the severe hazard of diaphragm breakage. It is virtually impossible to mechanically load the flexible diaphragm so nonuniform loads and diaphragm stretching never happen. In continuous-duty operation, these can lead to diaphragm failure.

Piston-diaphragm pumps get around both of these shortcomings. Here's how these unique pumps work.

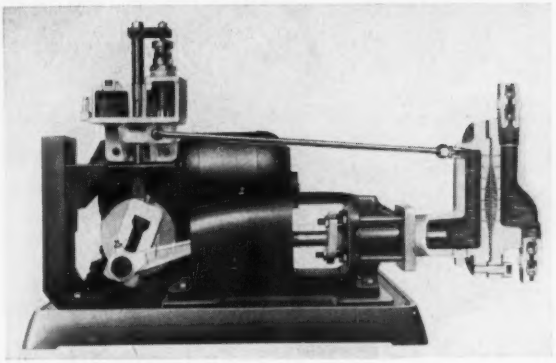
Basically, a piston-diaphragm pump is two pumps built together. First a simple reciprocating metering pump handles a nontoxic hydraulic fluid. Slight stuffing-box leakage here presents no problem—no danger and wastage only of relatively inexpensive hydraulic fluid. But this reciprocating pump doesn't really "pump", it "pulses" the hydraulic fluid in a fixed time-volume relationship. Pulsing fluid acts evenly and uniformly against a flexing diaphragm. Then the chemical-handling side of the diaphragm is fitted with suction and discharge valves in the regular way. Exaggerated drawings, above right, show suction and discharge strokes, diaphragm position in each case.

To insure accurate metering the hydraulic-fluid supply *must* be kept constant. It cannot be allowed to accumulate air or vapor—compressibility of these would take up part of the metering pulse and destroy metering accuracy. In some cases, constant supply depends on immersing the entire pumping action in the hydraulic fluid. Then two spring-loaded valves—one at the top and one at the bottom—vent trapped air and vapor and assure a constant supply of hydraulic fluid to the pumping element.

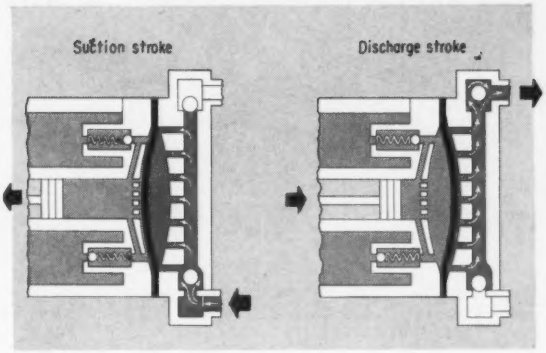
In other designs, a separate hydraulic system mounted on top of the pumping unit vents air and keeps the pumping element full of hydraulic fluid. This system operates mechanically directly from the crankshaft and functions on each stroke of the pump.

Metering capacity can usually be varied in infinite increments from zero to full flow by one or both of two means. First, the driving motor may be a variable-speed type. Second, the stroke of the reciprocating pump may be varied. This is done in some cases by shortening the crank throw. Or an intermediate wobble type crosshead can be adjusted to alter plunger stroke without varying the crank throw. In some cases the pump plunger is not directly attached to the connecting rod. Rather it bears against a spring-loaded plate whose lateral position can be externally adjusted. Then extreme position of the plunger is limited; effect is similar to short stroking and regulates capacity per stroke.

Latter two flow-changing methods can be adjusted while pump is running; adjustment can be manual or controlled by an ordinary pilot device actuated by process flow, pH or temp-



EXTERNAL HYDRAULIC SYSTEM operates mechanically on each revolution to vent hydraulic chamber and assure constant supply



LIQUID END of piston-diaphragm pump is exaggerated to show diaphragm and piston positions during suction and discharge strokes

By T W EDWARDS, Associate Editor

metering headaches

erature. Similarly, automatic control is possible from a remote location.

In another variation, air pressure is used to pulse the hydraulic fluid and flex the diaphragm. Pneumatic pump, right, uses a timer to operate a 3-way valve alternately pressurizing and dumping the hydropneumatic cylinder. The timer can, of course, be located at any convenient place to control from zero to full flow.

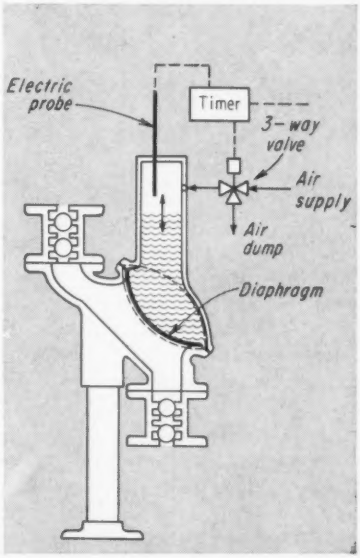
Or flow can be controlled by a stroke-changing device. An electric probe in the hydropneumatic cylinder makes contact with the rising surface of the conducting hydraulic fluid. This then controls the 3-way valve, admitting air and forcing the liquid level down to pulse the diaphragm. After a short delay, air pressure is dumped, liquid level raised by chemical suction pressure which reflexes the diaphragm until surface again touches the probe. Operating cycle repeats for each metering stroke of the pump.

Materials of construction are one big advantage of the piston-diaphragm pump. Leakage from stuffing box is noncorrosive hydraulic fluid, so most of the pump can be built of cast iron or steel. There's no need to take into account corrosion characteristics of chemical or liquid handled.

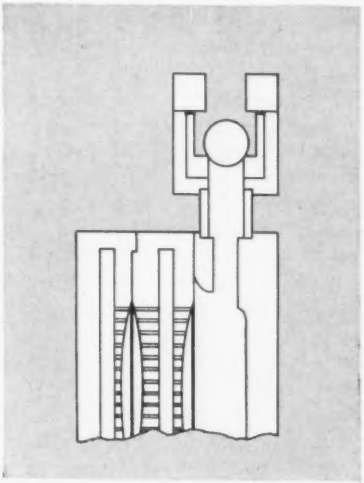
Diaphragm, pump casing and valves are only components actually contacting the pumpage. For these parts, materials can be selected to handle almost any chemical. Highly corrosive service commonly uses AISI-300 series steels, with diaphragm made of an inert synthetic. For very-high temperatures the diaphragm can be a thin stainless-steel sheet with high ductility and low metal fatigue characteristics.

Diaphragm-head designs are available to meet many other special services. Example: head at right is built to handle slurries. Note that outboard ported head is omitted to prevent possible clogging. Extreme flex of diaphragm is controlled by another, conventionally confined diaphragm in series with it. Liquid sealed between the two keeps the unconfined diaphragm exactly in phase.

Double-diaphragm construction has other uses, too. For safety's sake in extremely hazardous services, double diaphragm prevents contamination of major portion of hydraulic fluid. If primary diaphragm fails, a gage glass between the two diaphragms acts as a telltale, permitting repair before damage goes too far.



AIR-OPERATED PUMP is controlled by timer or electric probe which limits stroke



DOUBLE-DIAPHRAGM DESIGN for slurry service keeps unconfined diaphragm in phase

"Point system" streamlines pipe-size estimates

Most methods of calculating pipe friction losses are complicated, involving large charts and nomographs or complex formulas. But the point system—merely a summation of whole numbers—is easy to use yet highly accurate

For approximate friction-loss calculations in piping systems, you can't beat the "points" method. It's easy to use—no tables or charts to spread out—and amazingly accurate. Theoretical bases are normal pipe-friction formulas solved logarithmically.

Basic equation: pipe diameter = flow + length + pressure drop + initial pressure + temperature. Formula can, of course, be rearranged to solve for any unknown as long as you know the other values.

Examples, right, cover steam and water, but points are valid for other gases and liquids so long as turbulent flow is known to exist. In figuring gross pipe length, be sure to add straight-run lengths to center-line intersections, not face to face on fittings. List of fittings, right, is purposely meager—published fitting-friction data varies so widely that for estimating purposes you need only be relatively close. For fittings not shown, interpolate by using your own good judgment. Usually you will come close if you use the nearest whole point value rather than something in between. Exception: if you are measuring similar piping systems, one against the other, interpolating point values gives a better comparison.

Limitations to the point method must be watched. The method becomes increasingly inaccurate as you approach laminar flow—Reynolds numbers below about 2300. So the points system won't hold up well for calculating pipe sizes of lube-oil systems. In gas-flow calculations, it loses accuracy as pressure drops become large since gas density at the end of the line will be appreciably different from the beginning. As a general rule, don't use the points method for gas flows when pressure drop exceeds 25% of initial pressure.

Use it with good judgment and the points method of calculating pipe size or pressure drop can save you many tedious hours—especially during the estimating stages.

This article is based on information provided by A C Hutchinson, W H Allen Sons & Co, Ltd, Mechanical and Electrical Engineers, Bedford, England

Sample problems figure steam and water piping

Find correct pipe size to handle 15,000 lb per hr of steam at 185 psig, 650 F for a pressure drop of 8 psi through a 200-ft run with seven 90-deg l-r bends, two gate valves.

Pipe-length equivalent for fittings is then:

7 90-deg l-r elbows (7 x 20)	=	140 diameters
2 gate valves (2 x 10)	=	20 diameters
Start of pipe	=	50 diameters
Total	=	210 diameters

As a start assume a 6-in. pipe. So 210 diameters gives 105 additional feet. Total length of pipe is then 305 ft.

Now add points for all factors:

Steam flow, 15,000 lb per hr	64
Gross pipe length, 305 ft	25
Pressure drop, 8 psi	21
Pressure, 185 psig	12
Temperature, 650 F	8
Required pipe ID, 4.62 in.	130

But 210 diameters of 4.62-in. pipe is 97.0 ft—not the 105 ft we used. However, the points value for 297-ft gross pipe length is still 25, so you don't have to revise the calculation. Required pipe size, therefore: 5 in.

Find correct pipe size to handle 600 gpm of water flowing through three miles of straight pipe with a limiting pressure drop of 60 psi. First convert gpm to lb per hr (600 gpm x 8.33 lb per gal x 60 min = 300,000 lb per hr).

Now add up points for all factors:

Water flow, 300,000 lb per hr	90
Gross pipe length, 15,840 ft	42
Pressure drop, 60 psi	12
Water correction factor	– 2
Required pipe ID, 8.02 in.	142

Taking into account pipe wall thickness, you will probably need to use 10-in. pipe unless you can raise the 60-psi pressure-drop limit slightly.

Here are point values for factors governing pipe size you need*

Points	Flow, lb per hr	Pipe length, ft	Pressure drop, psi	Pressure or vacuum
				Press., psig
0	10	1	1000	2960
1	11.2	1.26	794	2430
2	12.6	1.59	631	1980
3	14.1	2.0	501	1590
4	15.9	2.51	398	1290
5	17.8	3.16	316	1030
6	20.0	3.98	251	822
7	22.4	5.01	200	657
8	25.1	6.31	159	523
9	28.2	7.94	126	415
10	31.6	10.0	100	327
11	35.5	12.6	79.4	256
12	39.8	15.9	63.1	202
13	44.7	20.0	50.1	158
14	50.1	25.1	39.8	122
15	56.2	31.6	31.6	94.3
16	63.1	39.8	25.1	72.1
17	70.8	50.1	20.0	54.5
18	79.4	63.1	15.9	40.3
19	89.1	79.4	12.6	28.8
20	100.0	100.0	10.0	19.9
21	112	126	7.94	12.8
22	126	159	6.31	7.1
23	141	200	5.01	2.6
				Vac, in. Hg
24	159	251	3.98	1.8
25	178	316	3.16	7.73
26	200	398	2.51	12.23
27	224	501	2.0	15.83
28	251	631	1.59	18.75
29	282	794	1.26	21.08
30	316	1000	1.0	22.93
31	355	1260	0.794	24.38
32	398	1590	0.631	25.55
33	447	2000	0.501	26.46
34	501	2510	0.398	27.18
35	562	3160	0.316	27.77
36	631	3980	0.251	28.22
37	708	5010	0.200	28.58
38	794	6310	0.159	28.88
39	891	7940	0.126	29.11
40	1000	10,000	0.100	29.29
41	1120	12,600	0.0794	29.44
42	1260	15,900	0.0631	29.55
43	1410	20,000	0.0501	29.65
44	1590	25,100	0.0398	29.72
45	1780	31,600	0.0316	29.78
46	2000	39,800	0.0251	29.82
47	2240	50,100	0.0200	29.86
48	2510	63,100	0.0159	29.89
49	2820	79,400	0.0126	29.91
50	3160	100,000	0.0100	29.93

Points	Flow, lb per hr	Pipe dia, in.
50	3160	0.116
51	3550	0.121
52	3980	0.127
53	4470	0.133
54	5010	0.139
55	5620	0.146
56	6310	0.153
57	7080	0.161
58	7940	0.168
59	8910	0.176
60	10,000	0.184
61	11,200	0.193
62	12,600	0.202
63	14,100	0.211
64	15,900	0.221
65	17,800	0.231
66	20,000	0.242
67	22,400	0.254
68	25,100	0.266
69	28,200	0.278
70	31,600	0.291
71	35,500	0.305
72	39,800	0.320
73	44,700	0.335
74	50,100	0.350
75	56,200	0.367
76	63,100	0.384
77	70,800	0.402
78	79,400	0.421
79	89,100	0.441
80	100,000	0.462
81	112,000	0.484
82	126,000	0.506
83	141,000	0.530
84	159,000	0.555
85	178,000	0.581
86	200,000	0.609
87	224,000	0.637
88	251,000	0.667
89	282,000	0.699
90	316,000	0.732
91	355,000	0.766
92	398,000	0.802
93	447,000	0.840
94	501,000	0.880
95	562,000	0.921
96	631,000	0.965
97	708,000	1.01
98	794,000	1.06
99	891,000	1.11
100	1,000,000	1.16

Points	Pipe ID, in.	Points	Pipe ID, in.
101	1.21	141	7.66
102	1.27	142	8.02
103	1.33	143	8.40
104	1.39	144	8.80
105	1.46	145	9.21
106	1.53	146	9.65
107	1.61	147	10.1
108	1.68	148	10.6
109	1.76	149	11.1
110	1.84	150	11.6
111	1.93	151	12.1
112	2.02	152	12.7
113	2.11	153	13.3
114	2.21	154	13.9
115	2.31	155	14.6
116	2.42	156	15.3
117	2.54	157	16.1
118	2.66	158	16.8
119	2.78	159	17.6
120	2.91	160	18.4
121	3.05	161	19.3
122	3.20	162	20.2
123	3.35	163	21.1
124	3.50	164	22.1
125	3.67	165	23.1
126	3.84	166	24.2
127	4.02	167	25.4
128	4.21	168	26.6
129	4.41	169	27.8
130	4.62	170	29.1
131	4.84	171	30.5
132	5.06	172	32.0
133	5.30	173	33.5
134	5.55	174	35.0
135	5.81	175	36.7
136	6.09	176	38.4
137	6.37	177	40.2
138	6.67	178	42.1
139	6.99	179	44.1
140	7.32	180	46.2

* Check these notes

"Points" are based on friction coefficient of 0.025. When actual coefficient is known, correct pressure drop by ratio of coefficients. Where pressure drop is the unknown, calculate it using tabulated points values. Correct answer by ratio of coefficients.

For water, omit factors for temperature and pressure and subtract two points.

Temperature points

Points	Steam* or gas, F	Air, F
4	—	25
5	0	280
6	200	470
7	400	700
8	600	1000
9	800	1400
10	1000	1900

*For 80% dry steam, subtract one point from the temperature points value shown

Saturation pressures for various steam temperatures

Temp, F	Pressure
100	28.06-in. Hg
200	6.46-in. Hg
300	52.3 psig
400	233 psig
500	666 psig
600	1529 psig
700	3079 psig

Allowance for pipe and fittings

(equivalent length in diameters)	
90-deg l-r elbow	20
90-deg std elbow	40
Gate valve, open	10
Globe valve, open	300
Tilting-disk check	100
Start of pipe	50
180-deg return	80

Stainless-steel stack goes up in one piece

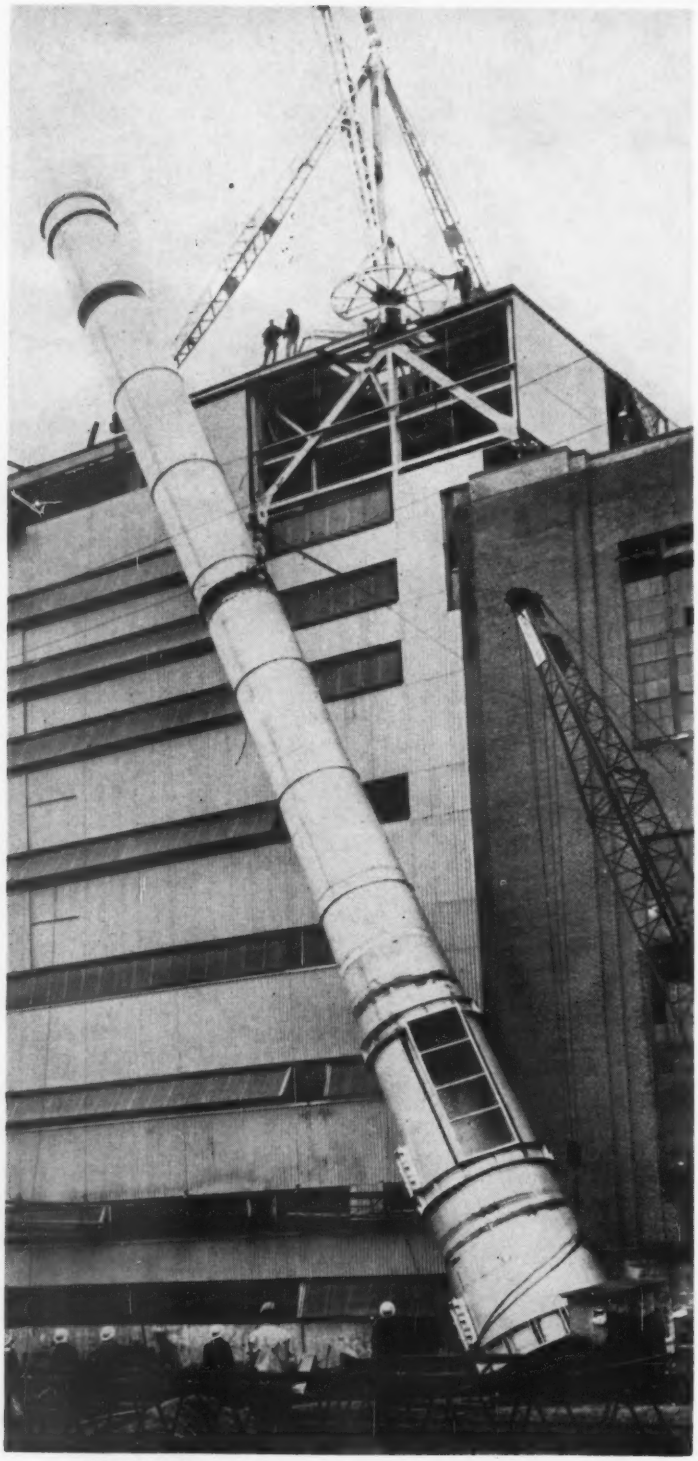
By P W DAVIS, Project Engineer
The Rust Engineering Company

Coordinated engineering, from drawing to final erection, turned a tricky power-plant detail into an opportunity for cost- and time-saving. This solution arose from specific situation in one plant, but many of our ideas may tie in with your plant's stack problems.

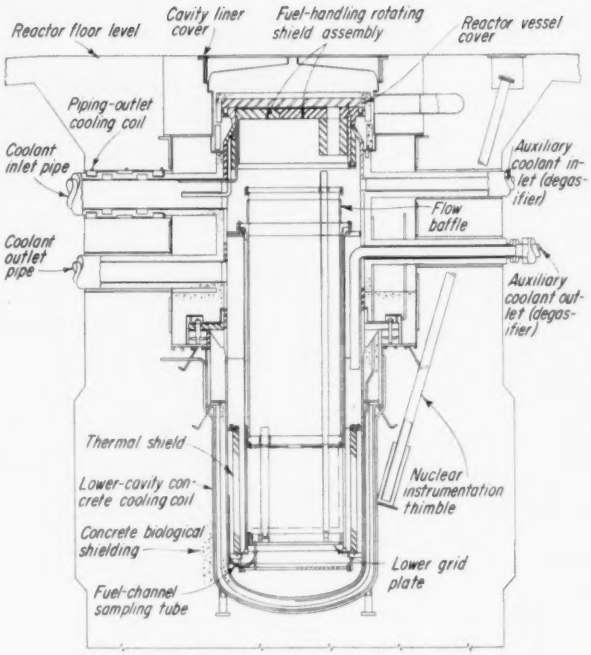
Modernization and expansion plans for one plant included a new 300-ton recovery boiler. Operation of this unit was integrated with existing recovery unit and steam plant. To shorten system connections we fitted the new unit in an ell formed by the existing recovery unit and steam plant. We found that structure of the steam-plant building adjacent to the new building was strong enough to carry new unit's stack with only minor additions of steel beams and concrete as actual stack base.

Stack materials were selected after extensive study of corrosion problems we expected to encounter. We chose 316-ELC 20%-stainless-clad steel for the main stack. Top 10 ft were made of solid 316-ELC steel to protect outside surface against possible downdraft corrosive effects. Also, we insulated with 2-in.-thick fiberglass mats chosen to withstand relative flexibility of the stack. Actual structural design was done by electronic computer in our Pittsburgh office.

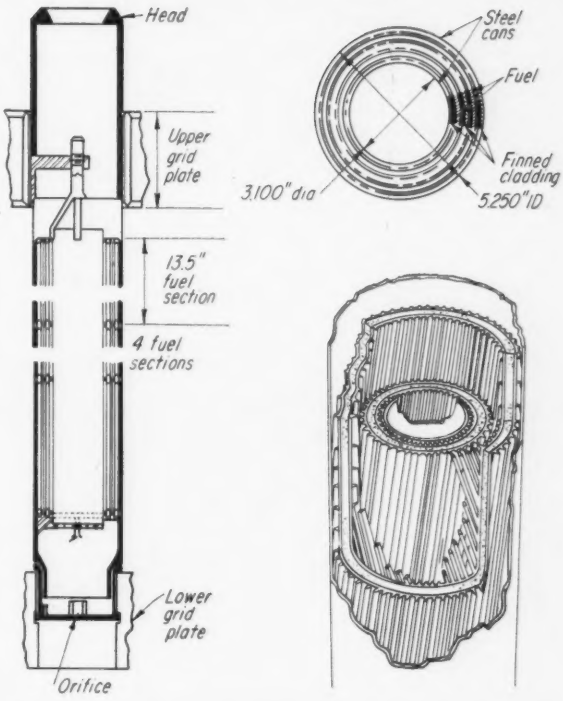
We ran into trouble at this point. A steel strike delayed materials for the stack, but not the building. Originally we planned to fabricate and erect the stack before new building's structural steel was in place. Now, to keep building costs and construction time to a minimum, we elected to continue building construction and put up the stack later, in one piece. By coordinating erection know-how at this stage we made minor modifications, came up with design described at left and solved our tardy-stack problem to our complete satisfaction.



PREFABRICATED STACK starts its journey to top of brick building, right. Stiff-leg derrick atop new recovery-unit building swung 125-ft 28-ton stainless-steel stack into place in one operation. Stack was raised, placed on its base and bolted in 47 minutes. To carry added erection loads we reinforced columns and added cross bracing in new building. Reinforcing, with exception of temporary base plates, remained as part of the building. Exact time for erection was chosen after learning local weather bureau's prediction that the wind velocity would be negligible or zero for several hours



1 Reactor core is held by two grid plates near bottom of reactor vessel. Organic flows downward through fuel elements



2 Fuel element is made up of four fuel sections consisting of tubular fuel alloy coated inside and out with finned cladding

Process steam from nuclear reactors

For some industrial processes with high load factors, nuclear reactors may offer economical steam. High fossil-fuel costs because of remote locations may be mitigated by nuclear fuel

By K S EDWARDS Jr* and ROBERT BERMAN
Atomics International

About 90% of the energy used on our globe is in the form of heat; only about 10% is electric energy. Process-heat consumption in the nations of the free world adds up to an equivalent coal consumption of more than 700-million tons annually. With fossil-fuel costs tending to rise as reserves diminish, nuclear energy may increase its share of industry's heat energy.

Today's reactor designs can produce large quantities of l-p steam at temperatures up to 600 F. More than a third of the energy consumed by manufacturing produces steam for process; this offers a large potential field for nuclear-reactor application.

Capital costs of nuclear plants currently are greater than conventionally fueled plants so reactor application takes more immediate interest in industries with high plant factors. Food, textiles and transportation have low plant factors, offer only a long-range potential. Pulp, paper, chemical industries and space-heating and sea-water-conversion systems combine substantial heat use with high plant factors and may find nuclear heat sources economical.

Improvement in nuclear technology will let us use reactor-supplied heat at temperatures above 1000 F. Work under way aims to solve radioactive-containment and -materials problems arising from the temperatures and pressures involved. Industrial processes that can use this heat include: reducing metals such as chromium, magnesium, titanium and aluminum; the synthesis of such basic chemicals as nitric oxide, acetylene, ammonia.

Organic-moderated reactor was suggested by Fermi over 15 years ago. A reactor cooled and moderated by an organic fluid has been under investigation for a number of years. It offers these basic advantages:

(1) The organic causes negligible corrosion so ordinary construction materials can be used.

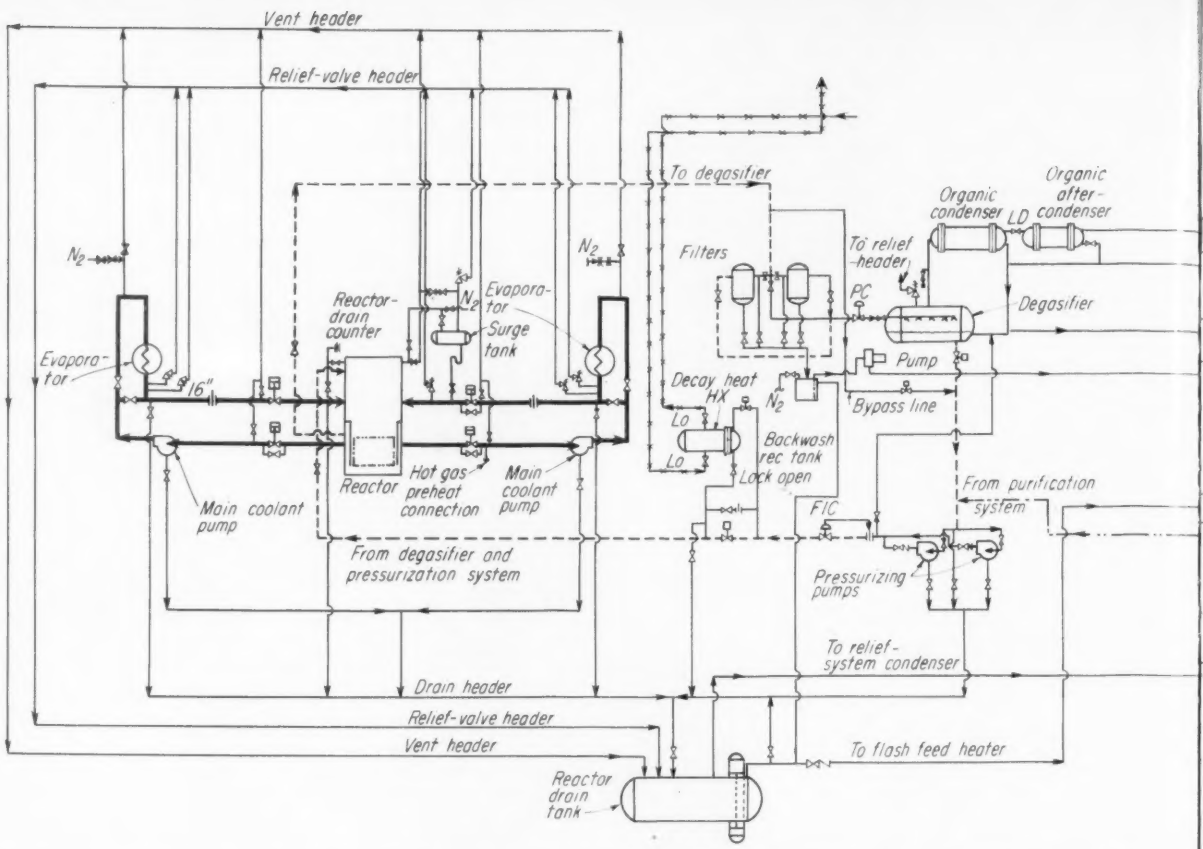
(2) The organic becomes only slightly radioactive, allowing substantial savings in shielding cost and maintenance inconvenience.

(3) There are no hazardous reactions between organic and uranium or water.

(4) Low fluid vapor pressure allows low operating pressures at reasonably high temperatures.

To establish technical feasibility, the Organic Moderated Reactor Experiment (OMRE) was built for

*Now with Vitro Engineering



3 Organic-moderated and -cooled reactor supplies heat energy to two evaporators or boilers through individual closed loops, left. Organic fluid completely fills heat-transfer circuits, the reactor vessel and the boilers, and is kept at 120-psig pres-

AEC; reactor has run since Sept 1957. Coolant has low decomposition rates, and there's no significant deposit of decomposition products on heat-transfer surfaces. The OMRE proved simple to run and maintain.

A 45-mwt OMR plant for Piqua, Ohio is now under construction. Larger organic reactors have been designed and European utilities are now considering several proposals. The organic reactor is one of the three types accepted for inclusion in the Euratom program.

Process-steam-plant application for the OMR has been studied, see table. The plants would use reactor and circuits shown in Fig. 1 and 3.

The reactor core stands near the bottom of the core tank which is about 6½ ft in diameter and 27-ft high. The organic fluid removes heat and also acts as moderator and reflector. The organic enters the core tank at the inlet plenum, flows downward through the core into the lower plenum, then upward through the annulus between core tank and thermal shield into the outlet plenum. From here it's pumped to the boilers.

In reactors with lower coolant temperatures, diphenyl may be used since it has a lower melting point (requiring less steam tracing and preheating), better heat-transfer characteristics and lower pumping-power needs. But higher vapor pressure limits its use at higher temperatures.

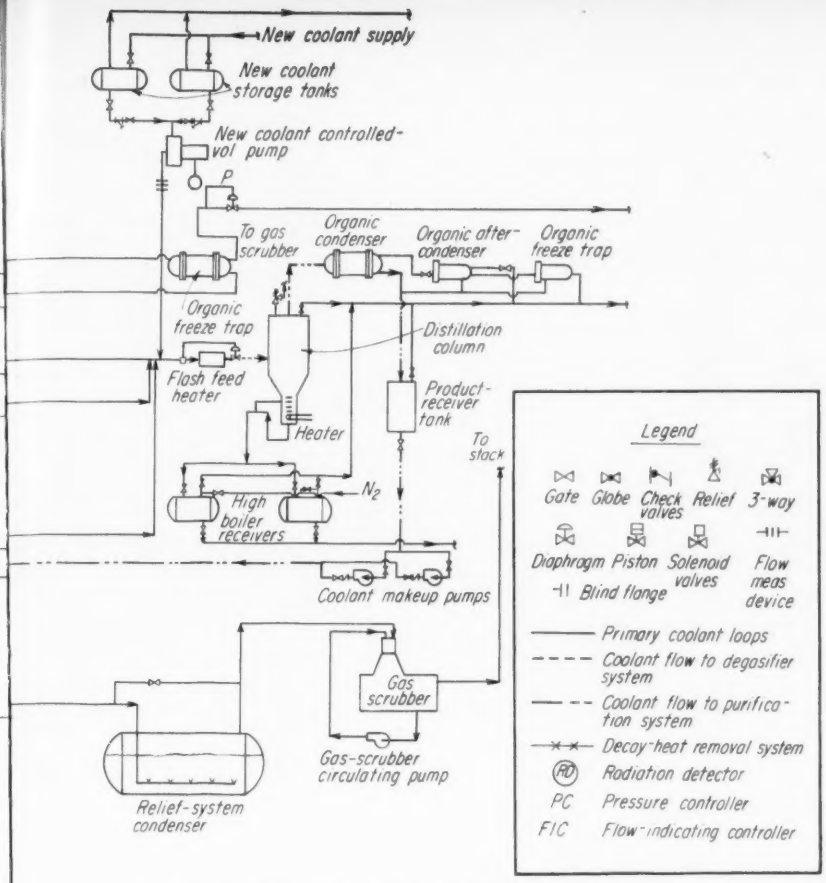
Compatibility of the organic with the system materials, low vapor pressure and the fluid's trait of becoming only slightly radioactive mean standard materials and construction methods can be used. So reactor vessel, piping and boilers are made of carbon steel. The centrifugal pumps are petroleum-industry standards.

A degasifier system continuously removes any gases or vapors formed through radiolytic decomposition of the organic, as well as other gases. A simple distillation system maintains the content of high-boiling compounds at a set level and purifies fresh coolant. Since most radioactivity associates with the residue, purification system acts as a decontaminator.

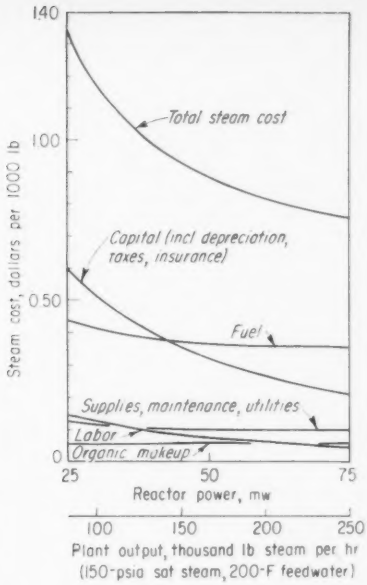
Reactor core has 85 fuel elements and 13 control rods set in close-packed array, with an approximately circular cross section. Steel grid plates above and below the core fasten to the thermal shield and support the fuel elements and control rods.

Reactor fuel is metallic uranium alloy enriched to about 2.0% U-235 and containing about 3.5% Mo and 0.1% Al. Aluminum cladding of the fuel alloy has fins to form an extended heat-transfer area. The cladding bonds metallically to the fuel through a diffusion barrier of nickel.

The fuel element, Fig. 2, is 5¼ in. in overall diameter and about 54-in. long. Uranium in the element forms two concentric tubes, each with a 0.2-in. wall thickness. Four of the 13.5-in.-long tubes make up an element.



sure by surge tank tied into loop. Main coolant pumps move organic against flow resistance of loops. Auxiliary equipment purifies organic by removing radioactive part



4 Steam cost from organic-moderated reactors falls with increasing capacity

OMR process-steam-plant comparison

Thermal power, mwt	25	50	75
Inlet coolant temperature, F	575	547	400
Average outlet temperature, F	630	605	490
Average heat flux, Btu per sq ft, hr	20,500	41,500	62,000
Flow rate, million lb per hr	2.9	5.5	5.5
Maximum heat-transfer coefficient, Btu per hr, sq ft, F	770	1330	1010
Maximum coolant velocity, ft per sec	8	15.6	14.6

Data based on 45-mwt physical plant built for Piqua, Ohio. Coolant is a polyphenyl mixture—largely terphenyl—operating at 120 psig

The cladding fins twist in a slight spiral along the length of the element, producing a spiral flow of coolant through the element, partly compensating for the hot-channel effect caused by variation in heat generation around the fuel tubes. Opposite twists of the two fuel tubes maintain concentricity.

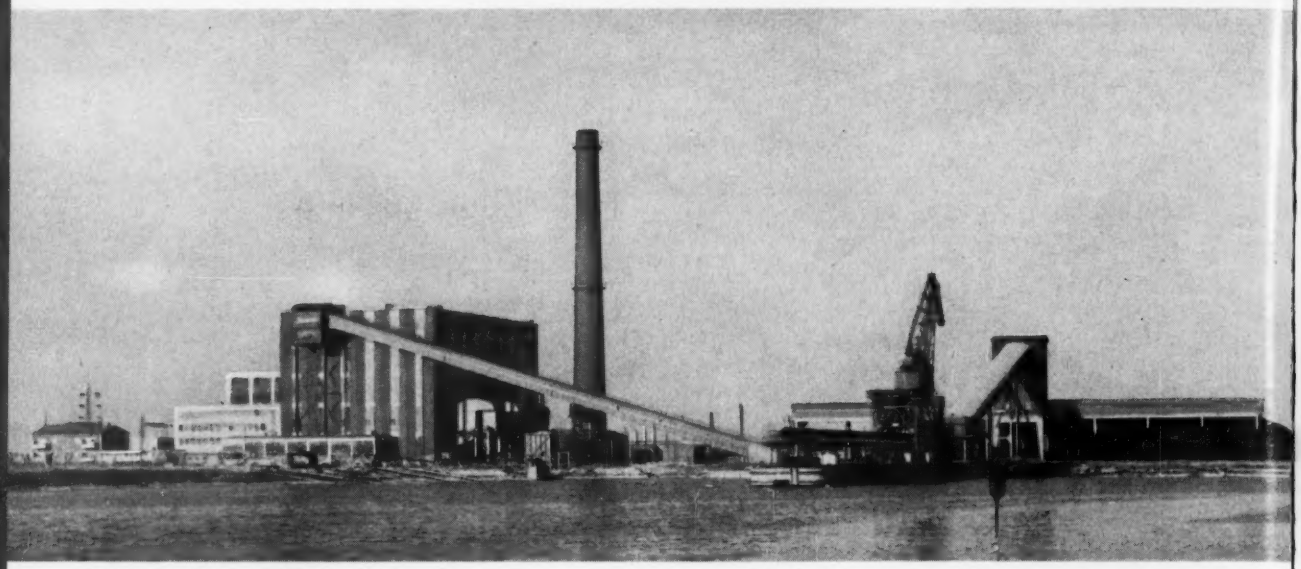
A fuel-element assembly positions between two steel tubes, the ends of which fasten to the upper and lower grid plugs of the assembly. The upper grid helps fuel-handling operations; lower grid plug seals against a flow-regulating orifice in the lower grid plate. All fuel assemblies use the orifices for economic heat removal.

Cylindrical control rods consist of tubular segments carried on tubular steel spindles. One rod is within the central fuel element, six in elements at a radius of about 21 in. from the center and the remaining six in elements at a radius of about 16 in. These form a 6-pointed star with elements at the center, roots and tips.

The OMR system runs at a relatively low pressure, greatly simplifying building design. Major structure completely contains all potential radiation sources by enclosing the reactor, steam generator, coolant pumps, new- and spent-fuel-storage facilities and the auxiliary system. While the general layout resembles other liquid-cooled reactor systems, h-p containment, elaborate shielding, intermediate coolant loops aren't needed.

Cost of process steam from OMR plants varies with the reactor power level, Fig. 4. It ranges from about $1.35 per 1000-lb steam for the 25-mwt reactor to 75¢ per 1000 lb for the 75-mwt unit.

Fig. 4 also gives the cost breakdown. Organic makeup runs about one lb per mwhrt. This costs only about 5¢ per 1000 lb of steam. Research shows that makeup needs will decrease as more is learned about additives, optimum reactor operating conditions and improved coolants. Organic-cost reduction from the present 17¢ per lb appears likely for any substantial production volume.



ORESUND POWER STATION in Malmo, Sweden burns coal and oil, stores about 60,000 tons of coal. Plant will eventually expand to 390-mw capacity from present 240 mw. Annual energy output of plant varies by 1:20 depending on hydro energy availability

To full rating from cold in one hour

Swedish steam-electric station working in system with hydroelectric plants can pick up load in a few minutes from standby status or help raise system power factor

By OLOF G HAMMAR, Professor
Chalmers Tekniska Högskola, Göteborg, Sweden

Practically all Swedish power stations are interconnected. The power companies and the state power board have a system with 6500-mw hydro and 2000-mw steam capacity. The state board supplies some 40% of the total energy.

About two-thirds of the energy comes from hydro stations in north Sweden with transmission lines over 600-miles long. The other third comes from thermal plants near the southern consuming areas. At low and medium capacity factors, thermal power becomes competitive to hydro. So, since energy availability from the hydro plants depends on the weather, thermal-plant outputs cannot be predicted any more accurately than the weather over a year's time.

Oresund Power Station at Malmo belongs to the Swedish Power Company, Sydsvenska Kraftaktiebolag. Its four units' total capacity runs to 240 mw. Two 70-mw Ljungstroem steam turbines and one 30-mw unit built by De Laval are supplied by four boilers with a maximum rating of 374,000 lb per hr each; one 70-mw Ljungstroem turbine is supplied by a 570,000-lb-per-hr boiler. Steam pressure: 987 psia; steam temperature ranges between 930 and 970 F with feedwater temperature of 356 F.

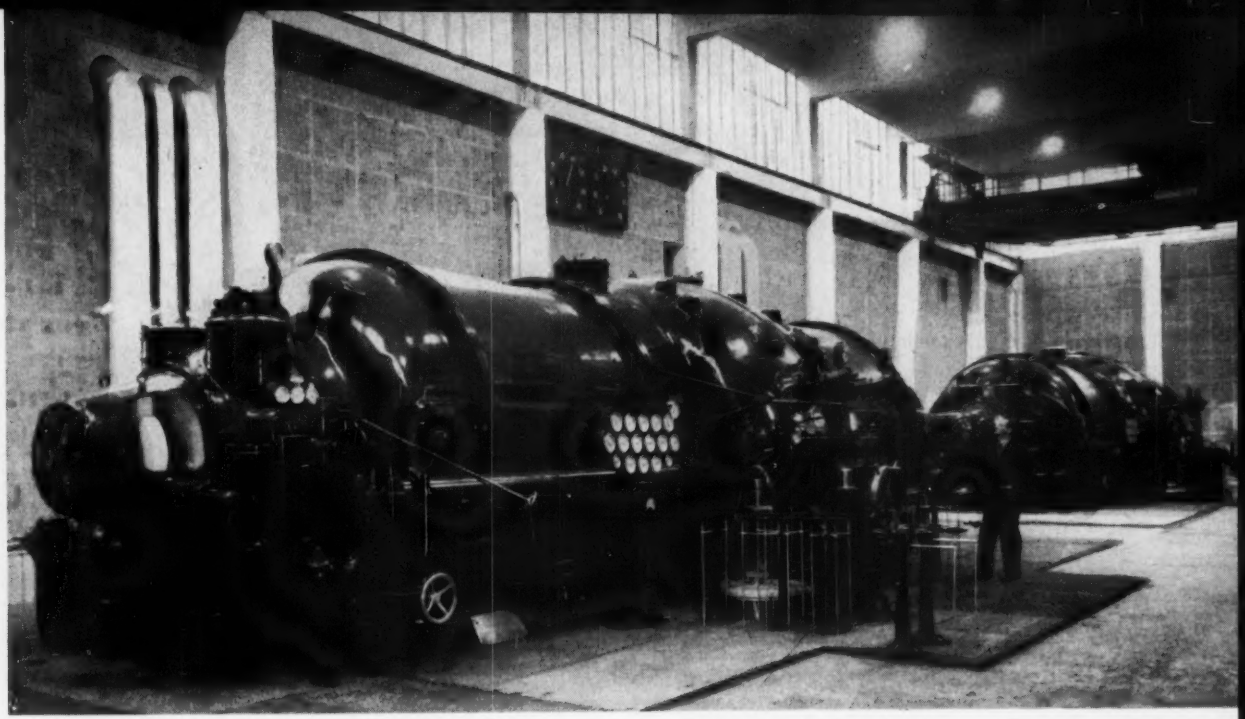
A fifth unit rated at 150 mw with reheat is in the design stage.

During low-water periods the plant runs 10 to 14 hours daily at about rated capacity and shuts down at night. Sometimes it has run continuously for over six months. Annual outputs have varied in the ratio of 1:20. During high-water periods the plant supplies peak loads of short duration on the system.

Oresund runs on hot standby to pick up load dropped by transmission-line outages. The generators run as synchronous condensers when not needed for load, with cooling steam flowing through the turbines.

Coal and oil are burned, both being imported. The plant stores about 60,000 tons of coal. Principal domestic fuel of Sweden is peat.

Layout. The boilers stand in sin-



DOUBLE-ROTATION LJUNGSTROEM TURBINES of 70-mw capacity can be brought up to full speed from cold in less than nine minutes. Units run either at full load or as synchronous condensers with cooling steam through turbine, pick up load on frequency drop

gle file in the boiler house, their fronts facing the turbine room. Fans and dust collectors are outdoors with one chimney serving first four boilers, a second for the fifth boiler. Overhead coal bins and an auxiliary bay stand between boiler house and turbine room. A common operating floor stretches through entire plant.

This layout was chosen to keep internal communications as short as possible for easier supervision–vital for the frequent starts and stops inherent in emergency standby. Most of the plant controls and instruments are in a relatively small area but near the machines they monitor. Result: fewer of the extensive automatic controls and distant-reading instruments needed in a central control room.

Four boilers supplying the first three turbines are Steinmuller radiant type with these heating surfaces and specifications:

Boiler & waterwalls	15,100 sq ft
Superheater	22,600 sq ft
Economizer	12,800 sq ft
Air preheater	51,300 sq ft
Furnace volume	30,800 sq ft
Air leaving preheater	510 F
Gas leaving preheater	293 F

Pulverized-coal firing evaporates only 290,000 lb of steam per hr. Each boiler has six Peabody swirl burners for combined coal and oil firing and burns a maximum of 5500 lb of oil per hr. A small chain-grate stoker at the furnace bottom has 135-sq-ft area, making it easy to run the boilers at low rates to furnish cooling steam.

Oil pressure at the burner fluctuates over a range of 313 to 455 psig. Oil flow can be dropped to 1/7 of full load by differential-pressure control.

Furnace heat release at full load is 16,900 Btu per cu ft per hr. A constriction in the upper part of the furnace, about 16-ft below the pendant superheater, mixes the furnace gases to complete combustion.

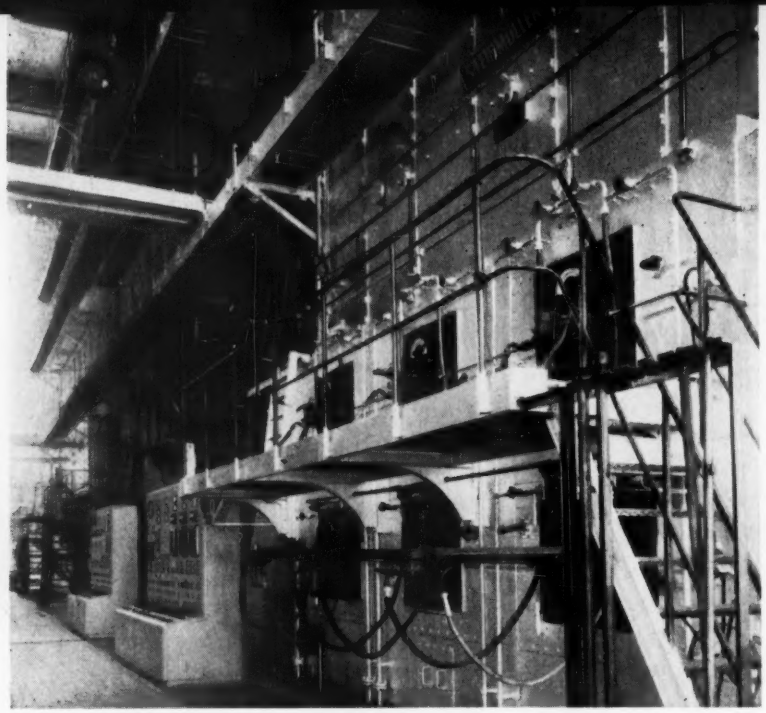
Boilers have been brought up to full steaming capacity from cold at 130 F in less than one hour. For rapid starts the f-d fan runs at full speed. About half the air passes through the air preheater to coal mills and burners, remainder flows through nozzles in the upper part of the furnace to mix with the combustion gas just before the superheater. So gas temperature stays down to 1100 F until about half the full-load firing rate is reached and the superheater is protected when no steam flows through it during early part of starting.

This procedure passes large gas flows through the economizer during lighting off. To prevent steaming in the economizer a pump circulates water through the unit.

Three of the boilers control superheat temperature by using surface coolers in the boiler-circulation system. In the other boiler, superheater's second section and the economizer stand in parallel gas passes. Dampers after the economizer and air preheater regulate flow of gases through the parallel passes to control superheat temperature.

Special lightweight refractory material in parts of the boiler brickwork reduces the heat capacity and so shutdown losses of the boiler.

Two drums per boiler stand one above the other. Riser and downtake tubes and the economizer connect to the lower drum. While the lower drum is almost completely filled with water during operation with practically constant level for different loads, water level of the upper drum can vary widely. On sudden load increase the water level rises; there's also a reserve of water in case of irregular



STEAM GENERATORS, each with six combination pulverized-coal and oil burners, are individually controlled from panels at units by automatic system or manually as needed

With reliable control a main goal, designers chose direct observation of equipment by operators

feedwater flow. This arrangement increases capacity of the boiler's accumulator action; dropping pressure flashes water to steam.

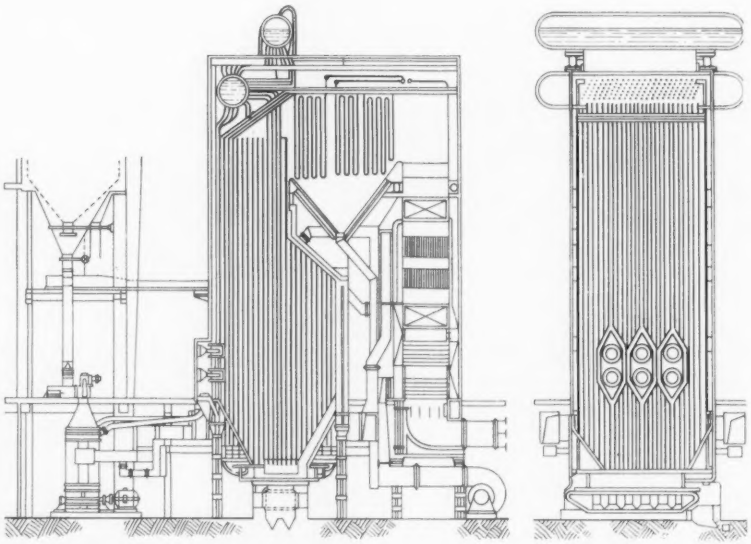
Firing extremely high-moisture coal means raising the air temperature to the mills above normal. Small oil burners can be built into the air ducts leading to the mills for this purpose when needed in the future.

Forced-draft fans on the operating floor draw their air from the top of the boiler house. A steam heater in the air ducting before the air preheater can raise air temperature from 85 to about 140 F, to counteract corrosion when the flue-gas dew point runs high. Heating steam is bled from the turbines when the station carries load or taken from the boiler at light loads when bleed pressure is too low.

Each boiler has both an f-d and an i-d fan. Each fan includes two motors for different speeds:

Fan	*Motor kw*	*Shaft rpm*
F-d	225	785
F-d	450	985
I-d	125	420
I-d	325	590

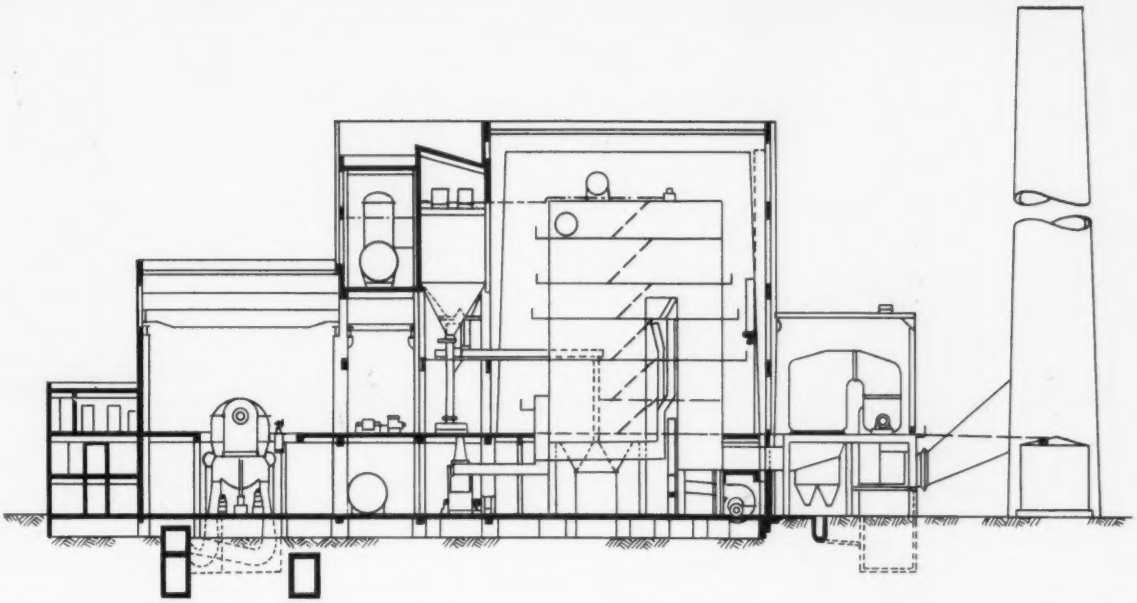
Adjustable guide vanes on fan inlets provide extra air-flow control. The smaller squirrel-cage motors give ample draft at normal loads with usual fouling. Larger motors produce ample draft in case of excessive slagging and deposits in the gas passes.



QUICK-LOADING steam generators use two drums for accumulator capacity and a chain-grate stoker for low-load cooling-steam operation when the plant is running on standby

Three turbine-generators are double-rotation Ljungstroem-STAL radial-flow units, each rated 70 mw, 72 mva, 50 cycle, 1500 rpm at a steam pressure of 987 psia and temperature of 968 F. The 11-kv alternator output is stepped up to 120 kv in an outdoor transformer. A separate overhead line transmits energy from each machine to a central switching station—there is no switching station at the plant.

These double-rotation turbines can be started by one man, run up to speed and synchronized to the line in



PLANT LAYOUT features operating floor at one level throughout plant. Internal communications are kept as short as possible for easier supervision—a bow to the starts and stops of standby service. Precipitators and i-d fan, right, stand out of doors, crane above

less than nine minutes' elapsed time.

The turbine governor can be made insensitive over a range of ±0.7 cycle. When frequency falls below a preset value the turbine takes on load automatically. This can be done at any load level down to no load when the turbine-generator acts as a synchronous condenser taking only cooling steam. Maximum load, of course, depends on boiler capacity available on the line.

Each unit has two vertical-propeller cooling-water pumps. Normally both run at full load, though one pump can supply enough water with a slight loss in overall heat rate. One of the pumps has an extra motor to run at a lower speed during synchronous-condenser operation of the unit.

The turbines have four bleed points each for heating feedwater. All told, feedwater passes through six heaters, the other two recovering steam from different parts of the cycle. All feedwater is deaerated at 230 F in a heater on top of the 220,000-lb water-storage tank. Each turbine has its own feedwater-heating system, including water storage and feed pumps. Units interconnect after their h-p feedwater heaters.

The 30-mw De Laval turbine-generator serves as a house turbine when needed. Turbine can be modified to exhaust into a district-heating system in the future.

Plant auxiliaries are motor-driven with the exception of two steam-driven feed pumps. Large motors run at 3000 v and the small ones at 380 v. Power consumption on powdered coal runs about 5% of the gross output.

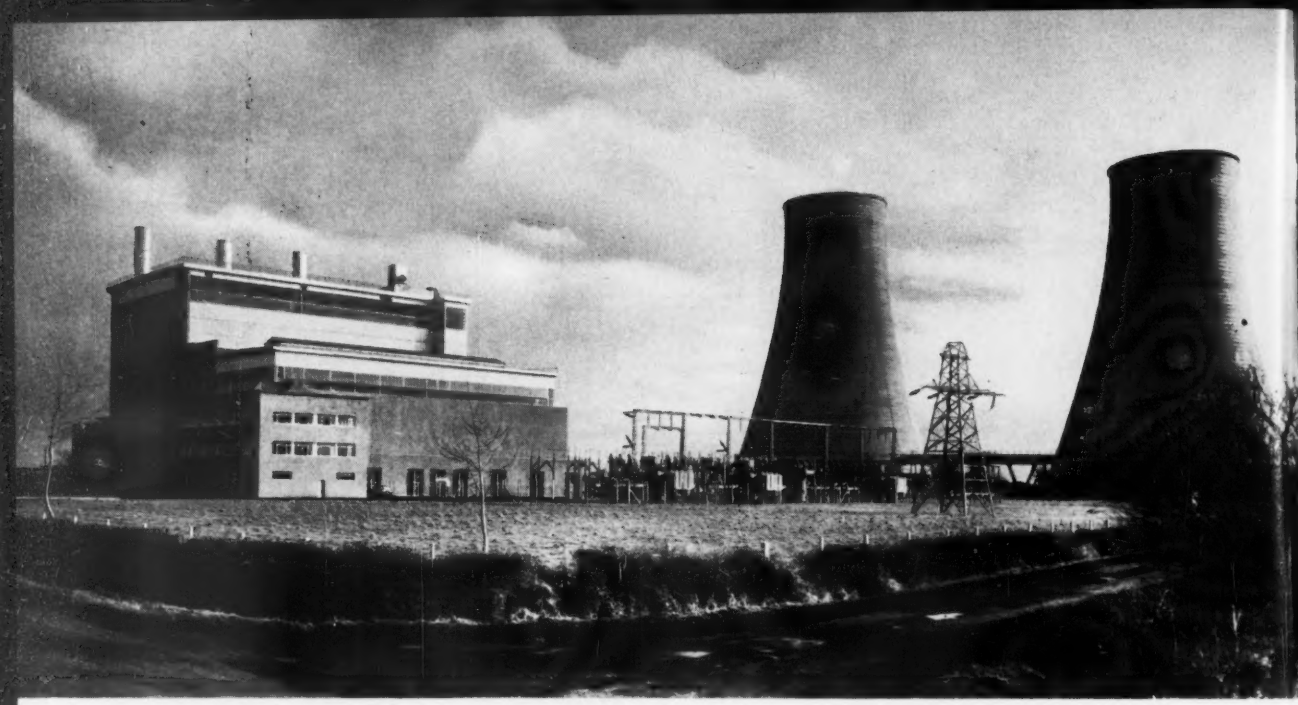
Transformers connected to the main terminals of the generator supply the auxiliaries of each unit. When the main switch of a generator is opened it still powers its own auxiliaries. Auxiliaries can connect to any one of the main generators in operation. With the plant completely shut down, auxiliary power comes from the nearby switching station via a 50-kva line and transformers. Breakers between the auxiliary bus sections interlock so main generators can never be tied together through the auxiliary system.

To increase reliability of the plant, motors of the auxiliaries are the squirrel-cage type. With a few exceptions, they do not have no-voltage releases. A brief drop in frequency can be tolerated and this avoids restarting motors by hand.

It is possible, however, for line disturbances to keep frequency considerably below normal for long periods and adversely influence the speed of the auxiliaries. This could throw the station off the line. Auxiliary buses can be supplied from the separate 30-mw house turbine during such troubles to keep the station running.

Combustion-control system by Hagan-Gordon supervises boiler operation. Manual operation from the boiler panels uses a compressed-air system of remote controllers. Boiler panels stand at the boiler fronts, turbine panels stand near the turbines for convenient operation.

Most plant auxiliaries stand between the boiler and turbine panels where they're easily seen by the operators and can be adjusted as needed with changing load conditions. A central control room was considered for the plant but finally reluctantly abandoned. The designers felt centralized controls would mean unnecessary complication of instrumentation to achieve rapid control of plant generation. Direct observation of plant equipment by the operators where possible was felt to be more reliable and reassuring than instruments receiving impulses from a remote plant location through a sending system.



FERBANE STATION has 60,000-kw installed capacity in three equal-sized units. Three steam boilers of 220,000-lb-per-hr capacity feed the units. Two hyperbolic cooling towers serve the station; each condenser needs 18,000 gpm of cooling water at 70 F

New Irish plant burns pulverized

Ireland has seven central plants burning sod peat which is handled manually. Now they've fully mechanized peat handling by pulverizing it in their new Ferbane Station

Peat deposits consist of partly decomposed vegetable matter that holds about 95% water. Peat bogs cover 15% of Ireland's area, but coal deposits are negligible in the Emerald Isle. So peat is the logical fuel.

To use peat as a fuel, moisture must be reduced to about 30 to 40% for sod peat and 40 to 60% for milled peat. In harvesting milled peat the bogs are divided into a large number of fields by 5-ft-deep drains on 50-ft centers. First the top heather and grass are completely removed; then 100-hp tractors pulling millers (like large lawn mowers) cut the top of the bog and spread it out for drying. After a few hours, tractor-driven harrows turn over the peat to speed drying by air and sun.

When the peat has dried to about 55%, ridgers (tractor-driven bulldozers with extra-long blades) pile it up in ridges in the centers of the fields. Next, harvesting machines move five of these ridges into piles paralleling a narrow-gage railway. Mechanical loaders pass the peat into rail cars for transport to our Ferbane steam-electric station.

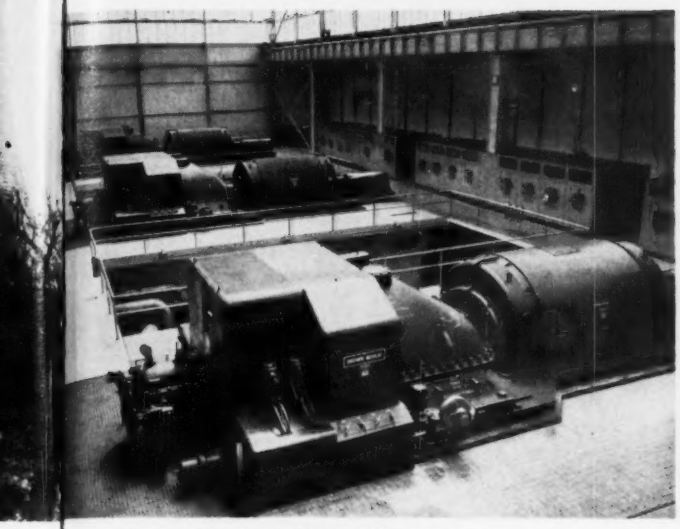
Harvests are made during spring and summer months at an average of 19 per season. Harvests yield an average of six tons of 55%-moisture milled peat per acre. An area of 12,000 acres produces about 1-million tons of milled peat yearly.

Average life of a bog in the area of a generating station is estimated at 25 years. Despite the full mechanization of harvesting milled peat, production can be seriously reduced by very wet weather. The Bord na Mona (Irish Turf Development Board) controls peat production.

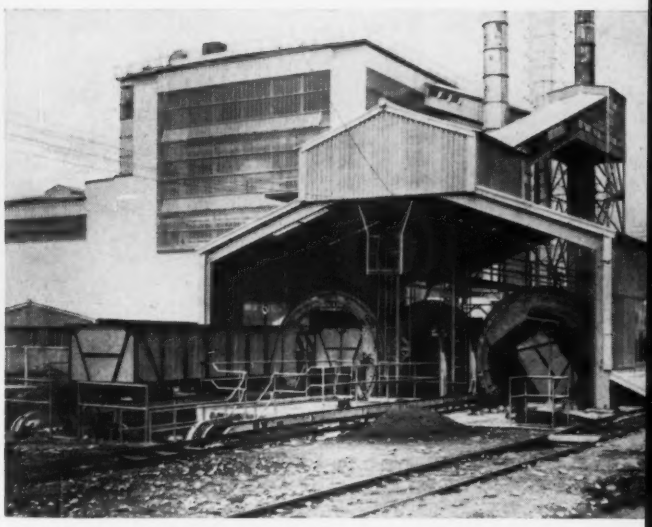
Design problems began with the bulk density of harvested peat, which varies considerably about an average of 20 lb per cu ft. Gross heating value at 55% moisture runs about 4200 Btu per lb; one cu ft produces 84,000 Btu compared to 575,000 Btu for one cu ft of coal. So for the same output a milled-peat station must handle about seven times the fuel volume of a coal-fired station.

Free flow of peat is vital. Experiments with bunker design showed best results given by two vertical walls with the other two at angles of 70 and 75 deg to the horizontal. Very large bunkers must be provided, so storage capacity is usually limited to eight hours' running.

Boilers for burning milled peat had never been built in Western Europe, and there was little data on Russian plants, so German experience in burning pulverized brown coal was stud-



THREE 20-MW TURBINE-GENERATORS take steam at 490 psig and 825 F. They turn at 3000 rpm, deliver 10-kv 50-cycle output



ROTARY CAR DUMPERS handle fifty 5-ton cars per hour in receiving peat for the plant. Automatic pushers feed cars in and out

peat

By W CRONIN, Generation Dept
Electricity Supply Board

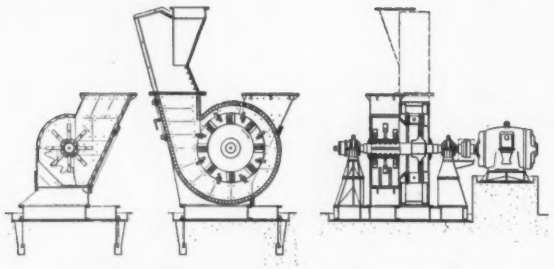
ied. Despite similar composition there are many differences in physical properties of peat and brown coal, table, next page.

Peat has a more-fluctuating moisture content than brown coal, about the same ash, but higher volatiles and oxygen content. Based on brown-coal experience the impact mill suggested itself as good for peat. Tests were made to find best speeds for beater heads, power consumption and particle size for combustion.

Fibrous matter in the peat strongly resisted milling; redesigning the beater arm overcame this problem. Explosion danger of a pulverized-peat-air mixture proved much higher than for coal; danger zone started at mill-outlet temperatures above 200 F. Combustion tests on boilers designed for brown coal showed that with suitable grinding and drying, milled peat

RIDGER BULLDOZES PARTLY DRIED PEAT from surface of the bog into center of field as the first step in hauling it from the bog to the pulverized-peat-burning station

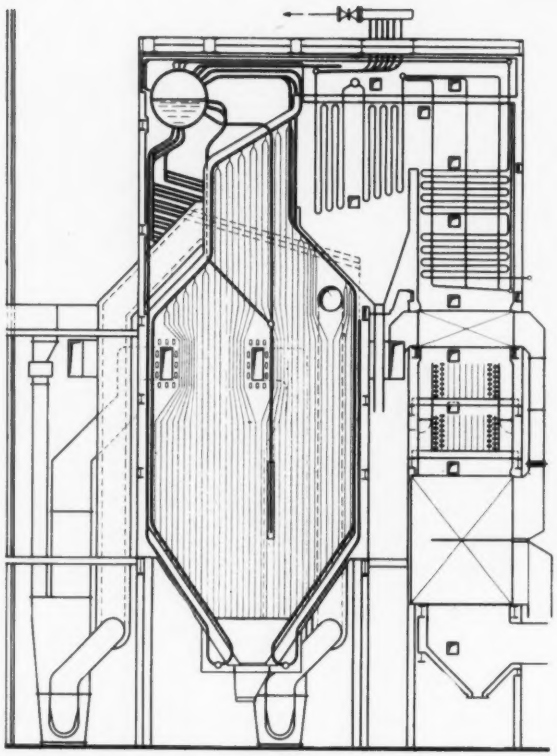
HARVESTING MACHINES MOVE RIDGED PEAT in successive steps from center of fields into narrow piles paralleling a narrow-gage railway for transport to the plant



IMPACT MILL WITH BEATER HEADS and exhaust fan was adapted from mills used for pulverizing brown coal in Germany

How milled peat and brown coal compare

Fuel	Milled peat	Raw brown coal
Moisture, %	40-60	60-62
Volatile matter, %	55-70	50-55
Oxygen, %	30-35	25-26
Ash, %	1-2	2-3
Heating value, Btu per lb	5300-3700	5600-5000
Ash fusion, F	1980	2070
Density as fired, lb per cu ft	13-28	—



BOILER NO. 1, by Vereinigte Kesselwerke, features primary and secondary furnace to produce long U-flame from burners at top

Steam generators for burning brown coal in Germany

could be burned in a boiler furnace.

For Ferbane Station, the Irish Electricity Supply Board ordered three steam generators with 220,000-lb-per-hr capacity to burn milled peat. One came from Messrs Babcock, Oberhausen; one from Walther & Cie, Cologne; one from Vereinigte Kesselwerke A G, Dusseldorf. The units are not identical—each firm incorporated its own experience—but outside dimensions are the same for all. The station at Ferbane formally opened in September 1958.

No. 1 boiler, Vereinigte Kesselwerke, has a combustion chamber divided into primary and secondary sections to get as high a heat release per sectional area as possible. The small cross-sectional area of the two chambers permits good combustion-air supply to the flame cone. Burners at the top of the primary furnace produce a long U-shaped flame path; this gives coarser particles time to burn out, or they can finish burning on the bottom grate of the furnace.

Acute deflection of the flame at the lowest point of its path thoroughly mixes the gas and air. Economizer section of the unit stands between two sections of the tubular air heater. Low ash content of the fuel led to choosing a dry ash-removal system.

Four Kraemer mills with 12-ton-per-hr capacity each feed one corner burner of the furnace. The mills are driven by 300-hp motors at 970 rpm.

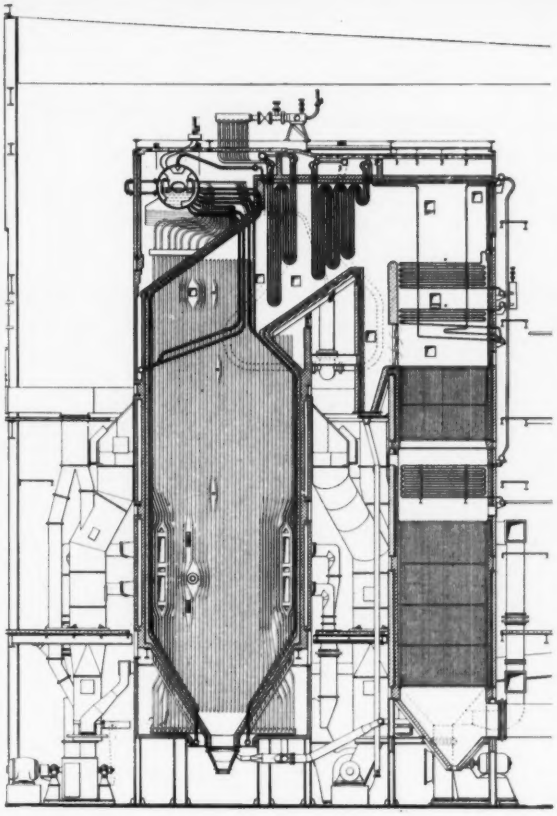
No. 2 boiler, Babcock, is also corner fired with one Babcock HGS mill feeding each burner. These mills combine a beater and fan, the fan exhausting the mill.

Plastic refractory covers the water-walls in the vicinity of the burners to form a stable ignition belt with low-grade peat. Resuction ducts, one for each mill, tap the top of the furnace at a point before the gases enter the convection heating surface. Gas temperatures here run at about 1300 F.

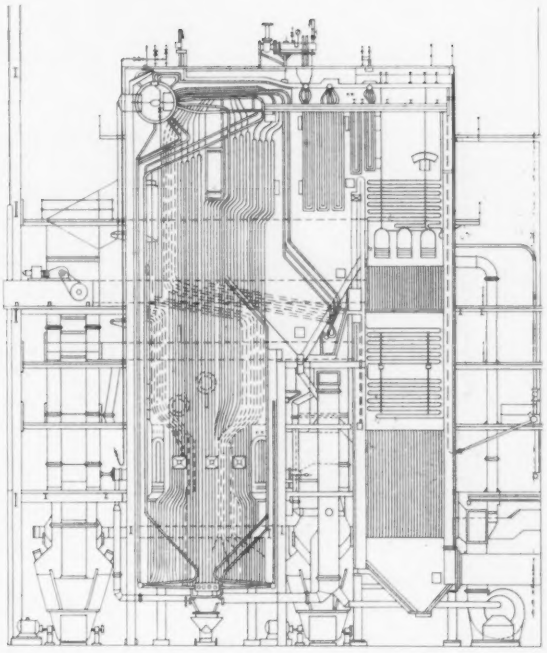
Hot gases and fuel enter the beater section tangentially for drying and milling. The fan draws out the pulverized peat and blows it into the classifier where the coarser particles are separated for return to the beater suction. From here the pulverized peat and gases blow to the burners. Final moisture runs about 30% at full load on the boiler.

Some mills are cut out of service for low-load operation. The burners feed horizontal layers of primary fuel mixture into the furnace at 50 ft per sec; secondary-air streams sandwiched between the fuel streams enter at 150 ft per sec.

No. 3 boiler, Walther & Cie, is fired by four 12.5-ton-per-hr Keller mills. The mills, driven by 300-hp motors, turn at 1400 rpm. Specifications of the Walther unit apply generally to all the boilers in the station as listed in the following table:



BOILER NO. 2, by Babcock, has burners in corners of furnace with water-cooled walls. Oil burners light off the peat



BOILER NO. 3, by Walther & Cie, like other units has 176,000-lb-per-hr normal rating, 220,000-lb-per-hr max continuous rating

were adapted to burn pulverized peat in Ireland

Heating surface, sq ft	
Boiler	9038
Superheater	10,275
Economizer	13,000
Air heater	55,000
Temperatures, F	
Feedwater inlet	290
Air-heater outlet	680
Stack-gas inlet	340

Each boiler has oil burners above the peat burners for lighting up. Each also has two f-d fans driven by 270-hp motors and two i-d fans driven by 230-hp motors. Each boiler has a self-supporting steel stack 165-ft high, 9½ ft in diameter, gunnite-lined to prevent steel corrosion.

Fuel handling. Diesel locomotives haul the 5-ton rail cars to the plant from the bogs. The cars automatically feed to two rotary car dumpers, each capable of dumping 50 cars an hour continuously.

Car-feeding device consists of an endless chain running from the dumpers to an idler pulley at the far end. The chain carries a number of retractable pushers making contact with a special plate fixed at the bottom corner of each car. Pushing device interlocks electrically with dumpers, remains stationary while cars are being dumped. Loaded entering cars push the empty ones from the dumpers. A short pusher starts each empty on its way to the marshalling yard.

Two 250-tph conveyor belts remove the peat from the dumper hopper. Each belt has an automatic weigher accurate to 1% and an automatic sampler. Fuel-handling plant was built by Messrs Hartmann.

Turbine-generators. Each boiler feeds one 20-mw turbine-generator built by Brown Boveri. The impulse-reaction units run at 3000 rpm. They exhaust to 24,000-sq-ft condensers. Two hyperbolic reinforced-concrete cooling towers, 266-ft high and 195-ft base diameter, cool the condenser circulating water. Each condenser needs 18,000 gpm at 70 F. Tower evaporation is 600 gpm and leakoff is 2500 gpm. Makeup comes from a nearby river.

Electric plant's 10-kv alternators tie directly to generator transformers for stepping up to 110-kv transmission voltage. Low-oil-content 110-kv switchgear was supplied by Siemens-Schuckert; rupturing capacity: 2500 mva. Station control room stands on the turbine operating floor.

Ferbane Station has run satisfactorily within limited moisture contents of the peat. No difficulty has arisen in maintaining normal boiler output with the fluctuating moisture. Average boiler efficiency based on net heating value is 85% at 55% fuel moisture.

Engineering staff of the ESB designed the station. They have two more stations under construction.

Planning to Burn Gas,

You can fire *ANY ONE* or *ALL THRE*

Inside the Turbo Furnace at Sterlington Steam Electric Station of Louisiana Power and Light Co. Overall width 54'—7⅞", depth 24'—0-3/16". No. 1 firebrick rubble covers the furnace floor. Twenty Riley Directional Flame Burners are arranged for opposed firing on front and rear walls. Burners are shop fabricated assemblies. Burner close-up shows directional vanes, two

The Riley TURBO FURNACE unit is one of the major furnace design advances in recent years for the more efficient utilization of fuels. It is known as a multifuel unit primarily because of its ability to produce similar furnace exit gas temperatures with gas, oil, coal or other solid fuels. This phenomenum is due to the fact that natural gas, which ordinarily burns with a non-luminous flame, burns in a TURBO FURNACE with a luminous flame similar to oil and coal. In a TURBO FURNACE, fuels are burned with extremely high turbulence at the furnace bottom.

Much of the unusual combustion efficiency is due to opposed firing with Riley Directional Flame Burners specially designed for firing multiple fuels singly or in combination. These fuels may be pulverized coal, oil, gas, or other special solid fuels such as fluid coke or lignite.

Water Cooled Burner

The Riley Directional Flame Burner is designed for opposed firing on one level. Each Riley Directional Flame Burner is installed as a unit complete with water cooling tubes which are welded to the waterwall circulation system. The waterwall tube arrangement provides maximum cooling of directional vanes, nozzles and other burner parts and reduces to a minimum the possibility of slag adhesion when coal is being burned. No burner refractories are required.

Coal Burning

Two or three burner nozzles per burner are provided when coal or other solid fuels are to be burned. In this way the coal streams are more evenly distributed across the furnace to assure good mixing of fuel and air in the furnace.

Oil Firing

A retractable type oil gun is inserted thru the center slot so as to provide complete mixing of the spray with the air stream. Oil can be burned with either steam or mechanical atomizing equipment.

Gas Firing

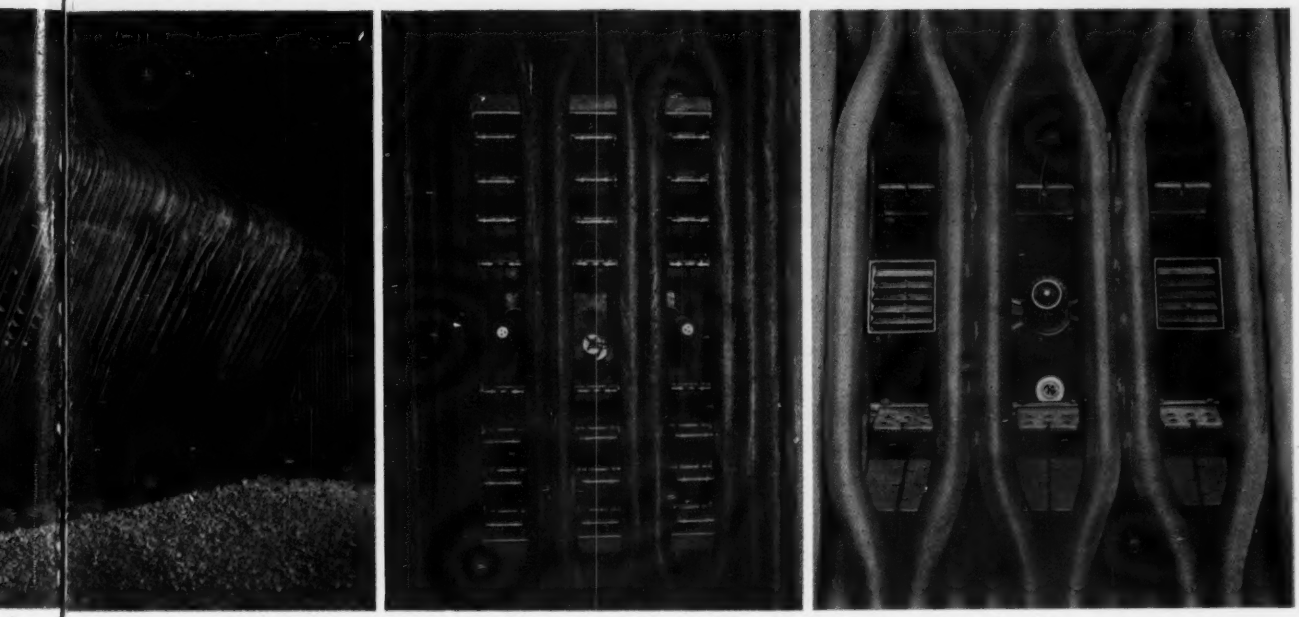
Gas is fired thru guns of high alloy stainless steel. High capacity burners have a gun in each side slot. Gas guns can be installed for mechanical retraction.

A RILEY TURBO FURNACE GIVES YOU THESE MONEY-SAVING ADVANTAGES

- **The ability to fire multiple fuels: gas, oil and a wide range of solid fuels**
- **A low cost and quick conversion to solid fuels with initial gas/oil firing**
- **Higher heat release with lower overall structure**
- **Minimum Superheater/Reheater metal temperature variations across full width of furnace.**
- **No restrictions on furnace widths.**
- **One level burner operation.**

Oil or Coal?

in a RILEY TURBO FURNACE



gas guns, gas electric ignitor, observation port. Burner can easily be converted to oil and coal firing. At far right is a Directional Flame Turbo Furnace Burner for firing coal, oil, and gas. Note the complete absence of burner refractory.

Directional Vanes

Each slot is provided with directional vanes to project secondary air into the furnace so as to secure the desired placement of flame for most effective combustion. The vanes above the burner centerline and those below each have separate controls. Vanes are made of high heat resisting alloy.

Burner Shut-Off

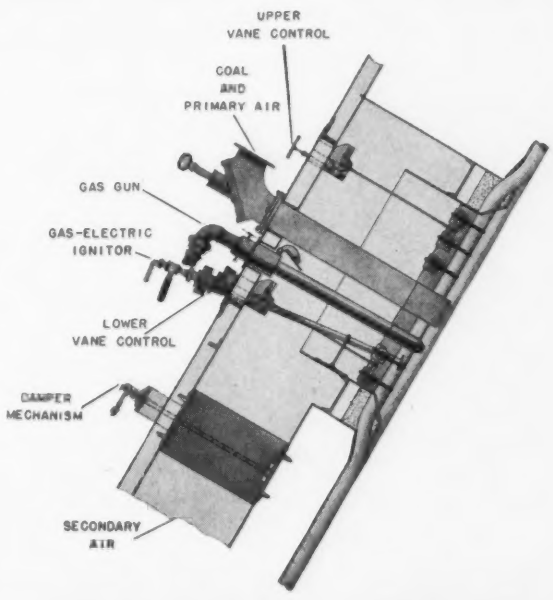
Each burner has a separate secondary air shut-off damper which can be locally or remotely controlled.

Riley Gas-Electric Ignitors

Riley Gas-Electric Ignitors are available with Riley Directional Flame Burners.

Pressurized and Non-Pressurized Operation

Riley Directional Flame Burners are designed so that they can be used either with pressurized or non-pressurized furnaces.



For the complete description of the Riley TURBO FURNACE write:

RILEY STOKER CORPORATION, Worcester, Mass.

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Boston, Charlotte, Chicago, Cincinnati, Cleveland, Denver, Detroit, Houston, Jacksonville, Kansas City, Los Angeles, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Salt Lake City, San Francisco, St. Louis, St. Paul, Seattle, Syracuse.

RILEY

STEAM GENERATING & FUEL BURNING EQUIPMENT

Nuclear notes

By B G A SKROTZKI, Associate Editor

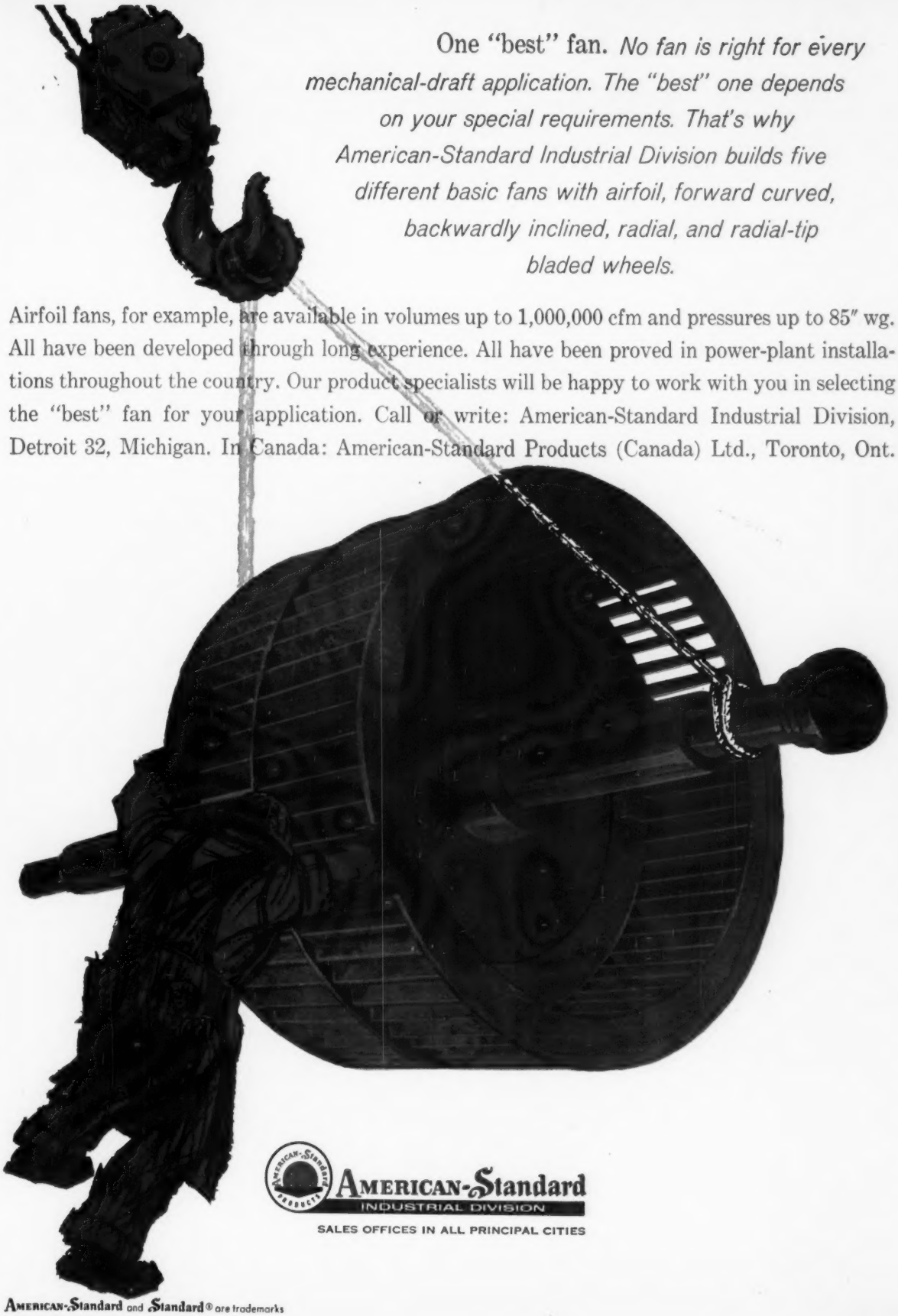
Explosion cause in the SL-1 Reactor at Arco, Idaho on Jan 3, 1961 has still not been uncovered definitely. Two crew members died instantly, the third within two hours from head injuries. Chemical and radioactivity measurements on a single fragment of reactor fuel ejected suggest the explosion produced about 50 mwsec or 1.4 kwhr of energy. The crew seemed to have been reassembling the control-rod mechanisms and housings on top of the reactor. Pressure generated within the reactor (possibly several hundred psig) vented through several partly closed nozzles in the reactor head and blew out shield plugs, parts of control rods and some fuel. The upward blast did only slight damage to the building. Damage to reactor is still unknown. Most likely cause seems to be a nuclear excursion produced by moving the central control rod.

Beryllium Oxide Reactor Experiment (BORE) design, construction and testing have been assigned by the AEC to the General Atomic Div of General Dynamics Corporation. They will develop a closed-cycle gas-turbine marine-propulsion plant powered by a high-temperature helium-cooled beryllium-oxide-moderated reactor. Fuel will be a mixture of uranium oxide and beryllium oxide. Construction is scheduled to start this year. Reactor core will be about 75-in. long and 24 in. in diameter, surrounded by a 7-in.-thick beryllium-oxide reflector. Design will allow helium temperatures up to 1500 F, pressures to 1120 psia and power levels to 10,000 kwt. A larger core and turbomachinery may be installed later at the plant in National Reactor Testing Station, Idaho.

Big Rock Point contracts were signed by the AEC, Consumers Power Company and the General Electric Company for the nuclear-power plant being built and financed by the utility at Big Rock Point, Mich. Reactor will go critical in Sept 1962. The project is under the AEC's Power Demonstration Reactor Program. High-power-density boiling-water reactor plant will be available for 4½ years for a research and development program demonstrating the feasibility of increasing power density of uranium-oxide-fueled boiling-water reactor cores. Initial fuel loading will run at 50 mwe, but program is expected to raise this to 75 mwe. AEC will reimburse the utility up to $500,000 for costs of R&D program, waive fuel-use charges of $1,650,000 for first five years of plant operation. In the contract with GE the AEC supports the program up to a maximum of $3,710,916, subject to escalation with a ceiling of 10%. Consumers Power estimates cost for plant, including site and preparation, at $27,762,000. Bechtel Corporation is designer and constructor.

Army Corps of Engineers has extended a contract with Alco Products, Inc to continue a technical study of the operation, testing and maintenance of three Army field nuclear-power plants. All three were designed by Alco: SM-1 at Fort Belvoir, Va.; PM-2A at Camp Century, Greenland; SM-1A at Fort Greely, Alaska. The contract is valued at $174,988 and will continue to Sept 1, 1961.

Research-ship atomic-reactor project was contracted between Euratom, GKSS of Hamburg and Interatom of Bensberg, Germany. Euratom will finance 40% of development and design of an organic-moderated and -cooled reactor. Interatom was formed in 1957 by Demag AG of Duisburg and North American Aviation. The reactor design is to be complete at the end of the year; then—hopefully—Euratom might take part in building a nuclear-research ship.



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Airfoil fans, for example, are available in volumes up to 1,000,000 cfm and pressures up to 85″ wg. All have been developed through long experience. All have been proved in power-plant installations throughout the country. Our product specialists will be happy to work with you in selecting the "best" fan for your application. Call or write: American-Standard Industrial Division, Detroit 32, Michigan. In Canada: American-Standard Products (Canada) Ltd., Toronto, Ont.

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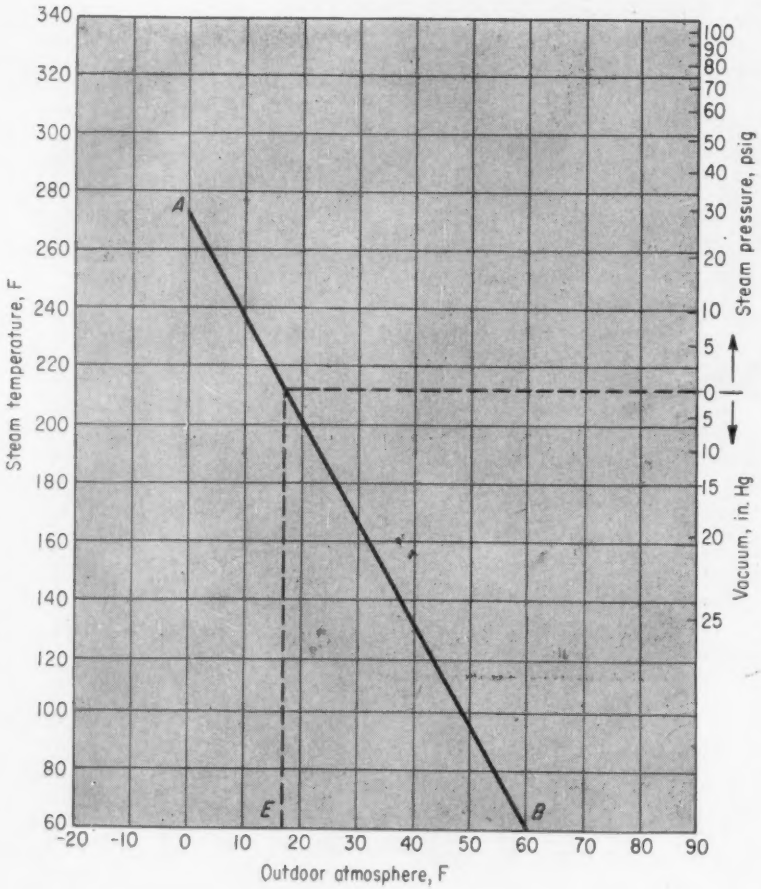
Power's data sheet

No. 343

Determine freezing point of heating coils, tubes and turns



To use this handy chart, first develop point at which anticipated minimum outside-air temperature intersects design steam-supply pressure. Next locate desired coil-delivery temperature on the outside-air-temperature scale and establish point at which this line intersects the same temperature on the steam-temperature scale. Trace a line connecting both intersection points. From this final line, steam temperature and pressure in the conductor are determined for all outside-air temperatures.

Example: air heater is designed to raise air from 0 to 60 F by means of controlled delivery temperature, using 30-psig steam. At what exterior-atmosphere temperature will controller reduce steam pressure in the heater to 0 psig?

Solution: locate intersection *A* of miniumum exterior temperature (0 F) and steam supply (30 psig). Find desired delivery temperature *B* (60 F); trace line *AB*. Establish intersection of 0-psig steam pressure and *AB*. At intersection trace a vertical to base and read result, 17 F.

As exterior temperature increases to 17 F or above, coil pressure drops to 0 psig or below, condensate is held in check in coils and there is a minimum hazard of freezing.

To apply this chart to your own installation, establish the temperature-pressure relationship for your heating-coil units. If various coils are designed for different terminal-air temperatures you'll need separate charts. If steam-supply pressure may vary, a range of slopes can be plotted.

W Anderson, *Oak Ridge, Tenn.*

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Here's a vertical turbine with

TERRY SOLID WHEEL

and all its advantages

When it comes to judging a turbine's ability to deliver in vertical service, ratings tell only half the story. It's the Terry construction refinements that give you assurance of long-range operational economy: Thrust bearing designed to absorb external pump thrusts ... carbon ring glands specially made for vertical operation ... casings and bearing housings split vertically for easy accessibility.

But most important, the Terry vertical turbine has an *almost* indestructible rotor. A single forging of special composition steel, it has no separate parts to loosen or work out. As the only function of the blades is to form a series of pockets, any wear which might occur would not materially affect horsepower or efficiency.

If your application demands a vertical turbine, specify Terry solid wheel. Available in capacities from 5 to 300 horsepower. And remember, the extra durability built into these vertical turbines is typical of every turbine in the complete Terry line.

For further information, send for a copy of bulletin S-137.

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For more facts circle 244 on Reader Service card, p 101

PARANITE OIL-PROOF and RAY-MAN CONVEYOR BELT

Over 20 Years' Uninterrupted Service At A Major New England Power Plant

The year: 1940. The requirement: 4,000 feet of conveyor belt to carry oil-treated coal from stockpile to boiler plant at a large electric light and power plant. This meant a "new" oil-proof conveyor belt able to withstand oil emulsion without swelling and causing excessive spillage. The recommendation: Manhattan's Paranite Oil-Proof Conveyor Belt with neoprene cover, one of the first all-synthetic rubber belts made for handling oil-sprayed coal and coke. Result: The Paranite Belt installation did the job . . . and continues to do the job today after twenty years of trouble-free service!

RAY-MAN BELT

Where oil is not a problem, Ray-Man Conveyor Belt will outperform all others. Precision proportioned for perfect balance. Double compensation relieves outer ply stress at bends. Trains naturally, holds fasteners better, resists impact and ripping, requires no breaker ply. Exclusive "XDC" cover for much longer wear. Troughs deeply for 45° idler operation to increase load capacity up to 60%. See your R/M Distributor or write for Conveyor Belt Catalog 25 CB.

CLOSE-UP VIEW OF PART OF 4,000 FOOT PARANITE CONVEYOR BELT. NOTE CONDITION OF BELT AS IT FLEXES OVER PULLEY. TWENTY-YEAR-OLD INSTALLATION IS THE LARGEST OF ITS KIND.

RM 115

RAYBESTOS-MANHATTAN, INC.
MANHATTAN RUBBER DIVISION • PASSAIC, N. J.
ENGINEERED RUBBER PRODUCTS

New Series of Marsh Needle Valves in 316 STAINLESS STEEL

—Valves that take you out of your corrosion problems

Now still wider service range for the valves that have set new standards in the needle throttling field. A full line of Marsh Needle Valves are immediately available in 316 stainless steel in the new series 1936.

Identified by **blue handles**

Here is a valve that opens up the wide range of corrosion-resistant applications bracketed by 316 stainless. It is a valve that gives precision throttling at pressures from a few pounds through 6000 psi . . . a valve for any temperature from minus 100° F. to plus 500° F. thanks to the "Marpak" packing system making use of precision moulded Teflon.

Only Marsh experience—in both valve making and instrument making—could have produced these valves. Like other Marsh needle valves, they are available in globe and angle patterns and in panel mounted types; sizes, ⅛″, ¼″, ⅜″, ½″, ¾″ and 1″. The 316 stainless valves are fully described in Bulletin NV-3.

Marsh Needle Valves are also available in 416 stainless steel (identified by green handles) and in mild steel (identified by yellow handles.)

The Marsh touch—
the precision touch—in every detail

- Body and stem guide machined from 316 stainless bar stock.
- Accurately machined stem, precision ground and rolled.
- Longer inlet and outlet thread chambers insure tight make-up.
- Packing as corrosion-resistant as the valve.

MARSH *Needle Valves*

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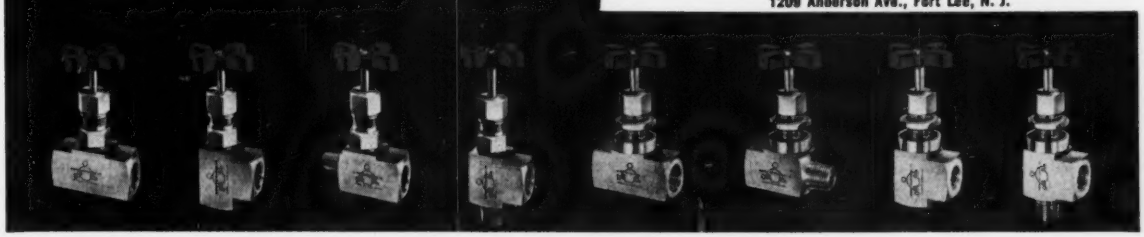


For more facts circle 246 on Reader Service card, p 101

Technical briefs . . . A world-wide look at

Fireside corrosion and fouling problems take the spotlight

A study of sulfur reactions in furnace deposits, *M Weintraub, S Goldberg, A A Orning, Bureau of Mines, U.S. Dept of the Interior*
Using a specially prepared test furnace, a study was made of absorption of sulfur from synthetic flue gas by coal ash. With temperature gradient similar to that normally found in a boiler-tube deposit, maximum absorption was in the coldest layer. At constant temperature this maximum came at about 1100 F.

Absorption was highest in flyash containing large amounts of sodium and potassium. Sulfur is probably absorbed as mixtures of normal sulfates, pyrosulfates and such compounds as potassium-ferric trisulfate. The liquid phase of these compounds in contact with tube metal causes corrosion.

Maximum sulfur absorption rate at 1100 F corresponds with a maximum at 1100 F observed for external-tube-metal corrosion. *ASME 60-WA-183*

New developments for handling the fuel-oil-ash corrosion problem, *D W McDowell Jr and J R Mihalisin, International Nickel Company*
Some fuels such as bunker C produce ash-containing vanadium pentoxide, sodium and sulfur compounds. These have a low fusion temperature; in liquid form they exert a fluxing action on metal oxides. Various approaches to this problem are under constant study: oil treatment, additives, protective coatings, furnace design changes.

Oil treatment is usually too expensive unless it can be done at the refinery. As corrosives multiply, selection of protective coatings becomes increasingly difficult. Effectiveness of additives is a function of care taken in their selection. Aim is to raise fusion point of ash. Some other properties needed: your additive must combine chemically with corrosive agents to form high-melting-point stable compounds, must be inexpensive, should have low molecular weight, must be commercially available in carload lots and must function equally well for all alloys in the system.

Results of some furnace-design changes are tabulated and operating experience cited. Lab test results cover popular metals. *ASME 60-WA-260*

Corrosion of superheaters and reheaters of pulverized-coal-fired boilers, *Carl Cain and Wharton Nelson, Combustion Engineering, Inc*
Temperature range of rapid liquid-phase corrosion of reheaters and superheaters depends on types and proportion of complex sulfates present. Lower limit for corrosion may vary widely, but upper limit is relatively constant at about 1300 F.

All alloys tested were subject to some degree of corrosion; shielding corrosion-prone surfaces remains the best remedy to date. Attack hits ash-accumulating surfaces between about 1025 and 1300 F.

Liquid-phase corrosion of austenitic alloys may be detected by inspection of the tube surface for pitting and notching and metallographic inspection for penetration of sulfides. Determining sulfide content of scale overlaying corroded areas or using a sulfur-print technique reveals difference between liquid and gas-phase corrosion of ferritic alloys. Then, once type of corrosion has been determined, proper prevention can begin. *ASME 60-WA-180*

Slurry spraying for the control of corrosion and deposits in oil-fired boilers, *W F Cantieri and R E Chappell, Diamond Power Specialty Corp*
Using additives to control corrosion and deposits in oil-fired steam boilers seems better than other methods tried to date such as precleaning oil or avoiding oils high in sulfur, alkalis or vanadium.

Three ways of getting additives into the boiler are: premixing with the oil, injecting through burners or ports in the furnace walls, spraying on the tubes through soot blowers. Latter method has proved successful in many cases. Advantage: additive slurry is placed where needed—directly on the tubes—minimizing waste. Operating procedure: (1) soot blowers are operated in the normal manner to loosen deposits (2) pressure is reduced to about 50 psi and additive slurry is injected to *distribute* slurry over the tubes, not *atomize* it and (3) slurry system is purged to prevent plugging. Usually one slurry application per day starting with a clean boiler is sufficient to control slag deposits.

Table compares experience for various additives, several application methods. *ASME 60-WA-284*

The role of chemical thermodynamics in analyzing gas-side problems in boilers, *R H Boll and H C Patel, The Babcock & Wilcox Co*
To predict flame temperatures, chemical thermodynamics have been used for determining concentration of thermally important constituents like CO_2, H_2O and CO. But now this technique is applied to such thermally unimportant constituents as NaOH, HCl and NO to form a background for studying fouling and corrosion. They are presented in graphs and tables as functions of temperature, fuel-air ratios and in some cases the fuel itself.

Discussion covers equilibrium limitations and transport and condensation of alkalis.

Mechanisms of superheater fouling and corrosion previously proposed fall into two categories: accelerated oxidation where the ultimate corrosion

product is always tube-metal oxide; attack by some agent other than oxygen where the ultimate corrosion product is a non-oxide compound such as FeS or $FeSO_4$. By purely thermodynamic means this study separates regions of oxidation and sulfation corrosion. Results agree well with experimental data. *ASME 60-WA-182*

Mechanical equipment

Vacuum deaerator design, *A W Kingsbury and E L Phillips, Pfaudler Permutit Inc*
Vacuum deaerators can be used to reduce O_2 and CO_2 content of cold water, cutting corrosion or process interference. A 2-ft-dia tower with maximum packing height of 22 ft was tested under variable operating conditions. Test results were correlated to form a practical basis for unit design.

Test apparatus is detailed including all auxiliary equipment serving the vacuum deaerator. Complete test results are shown in graphs and tables. Effects of packing heights on removal of noncondensables are detailed. *ASME 60-WA-214*

Wear limits for roller and silent chain drives, *H S Germond, Morse Chain Company*
Useful life of most roller and silent chain drives depends on wear limit—elongation or stretch in service—and rate of wear. But wear limits vary with service. Three wear-limit groups: sprocket-wrap, case-clearance and vertical-drive limit.

Sprocket-wrap limit is reached when the mismatch caused by chain stretch is about half a pitch. Then the chain tries to climb over or jump sprocket teeth. This limit in percent of stretch is about $200/N$, where N is number of teeth in the sprocket.

Case-clearance limit is point where slack side starts to contact protective guard. When the slack chain is in the upper span, case-clearance limit loses meaning unless the center distance is so long that the slack span touchs the lower tight span.

Vertical-drive limit may be very severe where upper sprocket is driving. Wear stretch tends to collect where slack strand engages lower sprocket—partially unwrapping so mismatch occurs. Here percent of wear limit is $25/TD$ (number of pitches in the tangent distance). *ASME 60-WA-8*

The centrifugal clutch coupling, *J E Ettorre, The Hilliard Corp*
Centrifugal-clutch couplings combine normal flexibility feature with several special torque-varying capabilities. Applications include starting high-enertia loads, dual drives, overload protection, occasional stalling loads and terminal-velocity brakes.

Directions for ordering these papers on p 100

Articulated shoes, mounted on internal driving hub, engage outer drum hub. Shoes may be leading, trailing or bidirectional; each type has different operating characteristics. Example: trailing shoes are ideally suited where slip at a very closely controlled overload is required; in general, leading shoes have higher hp capability at lower speeds.

In normal operation shoes are restrained by springs or bushings at driver idle speeds but engage at a set increased speed during acceleration. They then disengage at a set point during deceleration. Design and performance equations are detailed, thermal characteristics given. *ASME 60-WA-173*

Torque and cavitation characteristics of butterfly valves, *T Sarpkaya, University of Nebraska*
Drawing on past work by others, basic equations governing butterfly-valve operation were built up covering torque and cavitation characteristics. Then 2-dimensional tests confirmed much of the theoretical material developed.

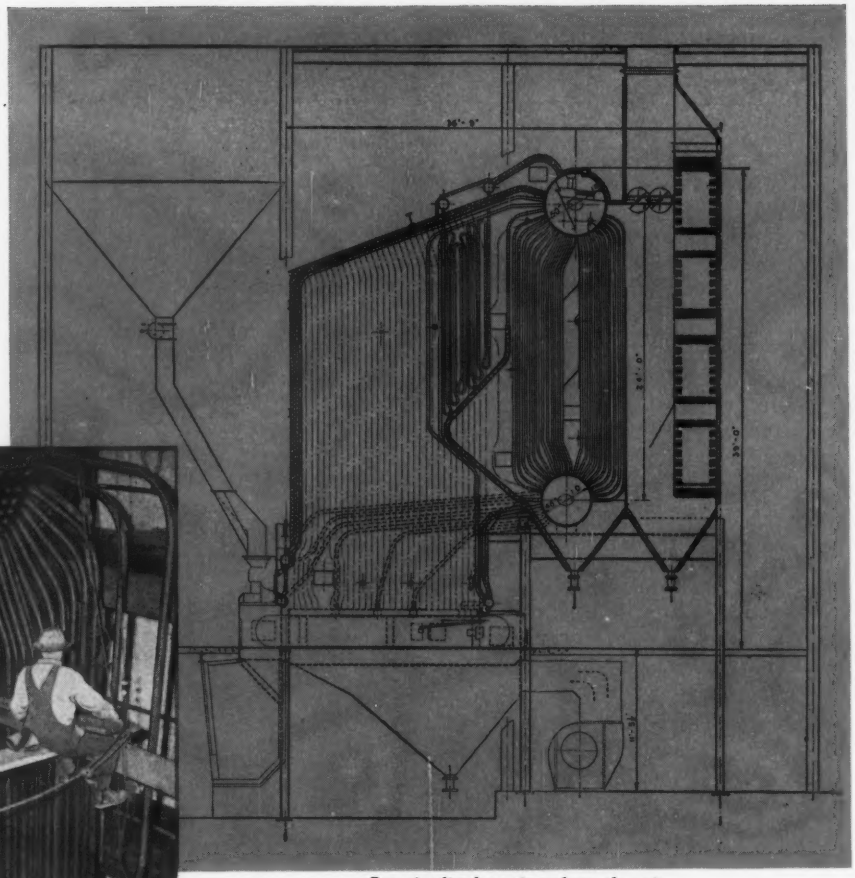
Conclusions: bulk characteristics of flow through 2-dimensional and axially symmetrical butterfly valves are essentially the same. Inception of cavitation can be predicted from comparative 2-dimensional studies as a function of valve-system geometry and upstream and downstream conditions. Needed torque varies widely for differing conditions, but it's perfectly definite and can be calculated when controlling factors are known. For a free-discharge valve, maximum torque-coefficient value is about 0.03 at 20 deg from the full-open position. *ASME 60-WA-105*

Economy of efficient air preheating with extraction steam, *M K Drewry, Wisconsin Electric Power Co*
Design and operating data from Wisconsin Electric Power's 275-mw Oak Creek No. 5 unit show that an overall heat-rate improvement of 2% has been realized from 2-stage steam air preheaters. Air temperature is 190 F with a 5-F terminal temperature difference. Side effects: steam air preheaters increase steam flow through hp turbine blading for the same electrical output, improving turbine efficiency in the same manner as extraction feedwater heating. Since an air preheater is in effect an auxiliary condenser using air instead of water, cost of the main condenser and its auxiliary facilities can be reduced. Under some conditions, condensing value alone largely justifies preheaters.

Until a practical way is found to cope with corrosion and fouling of low-temperature surfaces so flue gases may be cooled to about 200 F, steam air preheating seems to offer worthwhile economies. At Oak Creek, coal savings will pay for net investment in slightly less than two years. *ASME 60-WA-94*

continued

Union Starch Installs a Modern Coal Fired Steam Generator



Longitudinal section through unit.

Tubes being installed in steam and water drums.

PROJECT BY
ROGERS SCHMIDT
ENGINEERING CO.
ST. LOUIS, MO.

This 125,000 pounds per hour capacity Vogt Steam Generator, especially designed to burn bituminous coal, serves the Granite City, Illinois plant of the Union Starch and Refining Company. The unit operates at 475 lbs. pressure and delivers steam at 750°F. total temperature. It has water cooled front, sides and roof of furnace and employs a spreader type coal stoker.

Vogt offers a complete line of custom built and package type steam generators for power, processing and heating. Bulletins are available upon request.

Vogt

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STEAM GENERATORS

Begins on page 92

Performance testing

Methods for measuring steam turbine-generator performance, *K C Cotton, J C Wescott, General Electric Company*
While code testing is required for acceptance, interim checks of turbine operation can be made by much less expensive and time-consuming means.

Temperature - pressure measurements together with throttle and reheat flows and power output will give heat rates. One good way to measure flow is by enthalpy drop.

In temperature-measuring devices, only thermocouples and platinum-resistance thermometers are considered. But thermistors show great promise after additional research and development work.

Test accuracy can be confirmed by repeating; instrument drift readily shows up. Instrumentation hints for required accuracy are given. *ASME 60-WA-139*

A comprehensive approach to the analysis of cooling-tower performance, *D R Baker, H A Shryock, The Marley Company*
Lack of agreement on acceptable level of accuracy has hampered cooling-tower performance-testing development. Users are reluctant to permit a tolerance as high as ½ deg (this corresponds to 10% capacity at a 5-deg approach). And manufacturers' test needs are different from users'; their needs revolve around performance prediction at other operating conditions.

Errors in present mathematical analysis are pointed out, means of improvement cited. But there's no effort to evaluate the added work required to use these improvements—increased effort vs accuracy gain. It may well be that the game isn't worth the candle.

Remember that a method that does not give an acceptable degree of accuracy is worthless, no matter how simple and easy. So limits of minimum acceptability and maximum effort must be left up to the individual. *ASME 60-WA-85*

continued

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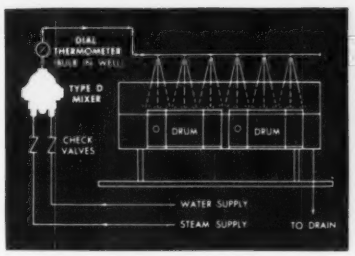
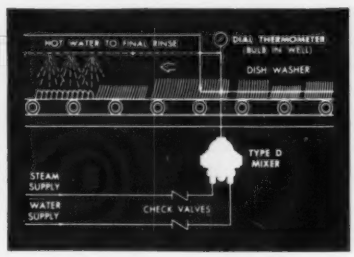
How To Maintain Uniform Process Hot Water Temperature





Schematics above show the function of Powers Type D Mixer in standard systems for maintaining uniform process hot water temperature where it is not practical to install or use a steam heated storage tank. These drawings are taken from the Powers *Engineer's Manual, Steam-Water Service* which is free to you for the asking. Each drawing is supplemented with detailed engineering information about the controls used. Everyone concerned with the installation and/or operation of steam-water service will find these diagrams a helpful guide in laying out a new system or updating an existing one. Other sections offer similar easy-to-follow diagrams and concise details on the following:

- Domestic Hot Water
- Hot Water Storage Heaters
- Instantaneous Heat Exchangers
- Heat Exchangers For Cooling
- Fuel Oil Heaters
- Pressure Reducing
- Jacket Water Cooling
- Two-Temperature Hot Water Systems

Fill in the above coupon to get your copy of this informative steam-water service manual.

POWERS CONTROL

THE POWERS REGULATOR COMPANY
Dept. 361, Skokie 24, Illinois
In Canada: The Powers Regulator Co. of Canada Ltd. Downsview, Ontario

For more facts circle 248 on Reader Service card, p 101

INSIDE STORY — HEV-E-OIL burner is the *only* commercial-industrial burner that successfully applies the principle of low-pressure air atomization of heavy fuels *inside the nozzle.*

HEV-E-OIL BURNERS

HEV-E-OIL commercial-industrial burners operate on the principle of low-pressure air atomization and furnish *all the air necessary for complete combustion.* This assures efficient, economical operation — perfect fire control regardless of weather or draft conditions. And HEV-E-OIL burners offer you *double savings!* They are especially engineered to make use of inexpensive heavy oils — number 4 and 5. Number 6 or Bunker C in larger models. Available from 5 to 150 gph.

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INDUSTRIAL COMBUSTION INC.

EXECUTIVE OFFICES: 4507 N. OAKLAND AVE., MILWAUKEE 11, WIS.

Technical briefs

Begins on page 92

Standards

Pipe Fabrication Institute *lists standards and technical bulletins now available:*

End preparation and internal machining for machined backing rings for butt welds *(ES1-1956)*

Method of dimensioning welded assemblies *(ES2-1949)*

Linear tolerances, bending radii, minimum tangents *(ES3-1957)*

Standard practice, shop hydrostatic testing of fabricated piping *(ES4-1959)*

Standard practice, cleaning fabricated piping *(ES5-1950)*

Builtup weld metal bosses *(ES6-1956)*

Welded nozzles, recommended minimum length and spacing *(ES7-1954)*

Recommended preheat and postheat welding practices for low chromium-molybdenum steel pipe *(ES(M)8-1958)*

Recommended practice for shielded metal-arc welding dissimilar ferritic steels *(ES(M)9-1959)*

Recommended practice for stress-relieving welded attachments *(ES(M) 10-1957)*

Recommended practice for permanently affixing identification symbols to fabricated piping *(ES11-1960)*

Recommended preheat and postheat welding practices for medium chromium-molybdenum steel pipe *(ES(M)12-1959)*

Classification of shop testing, inspection and cleaning *(ES 13-1959)*

Pressure-temperature ratings of plain-end pipe used in power-plant piping systems *(TB1-1960)*

Pressure ratings for 90-deg unreinforced branch connection of seamless-steel pipe *(TB2-1956)*

New screw-thread standards for federal services, 1957, Part III, *National Bureau of Standards*

This volume is the third of a series into which the 1957 edition of NBS Handbook H28 has been divided. It covers acme, stub-acme and buttress threads; rolled threads for screw shells of electric-lamp holders and unassembled lamp bases; microscope-

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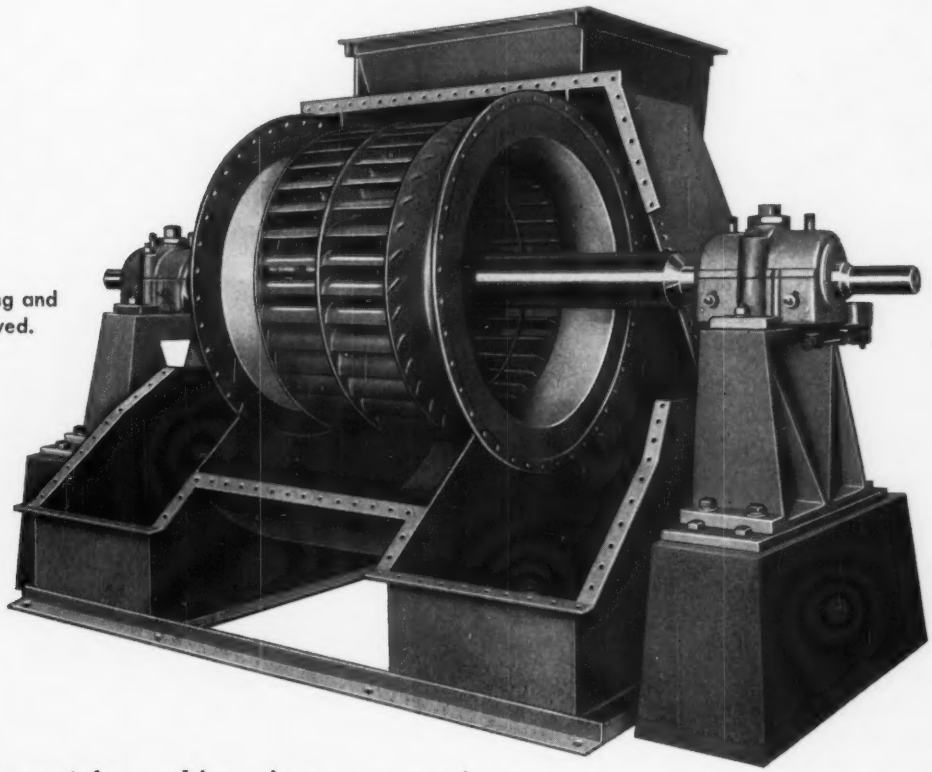
HAS WHAT IT TAKES for induced draft, toughest fan service of them all! The Clarage Dynacurve Fan is built extra heavy for extra service life. Compact design minimizes floor space and height requirements. Rugged wheel has 36 radially deep, aerodynamically curved blades and tapered rims. Optional wearing plates go where they belong—on the **face,** not the back, of the blades. Optional scroll liners are **bolted,** not welded, for easy replacement. Save cost, save space. Choose Clarage.



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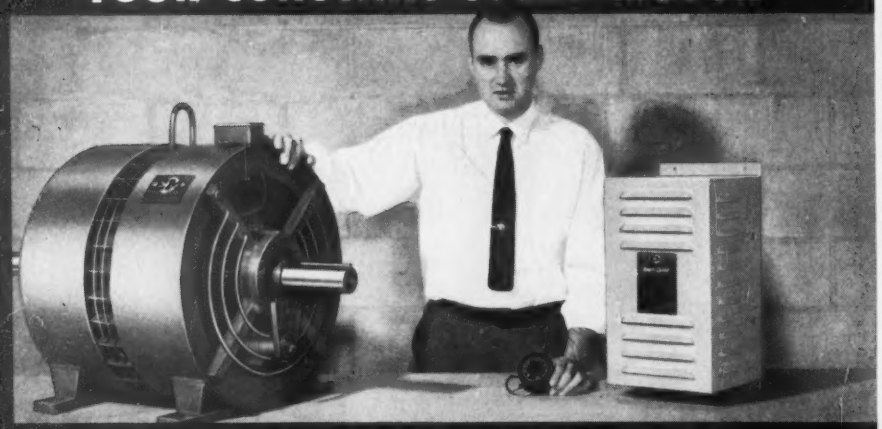
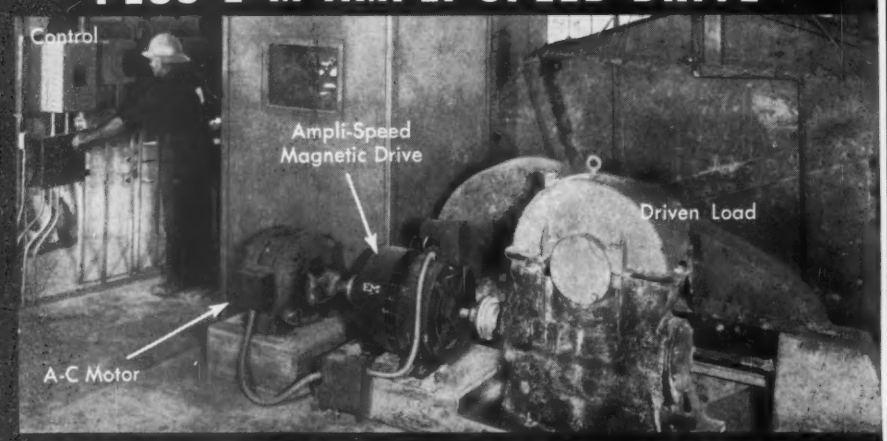


PLUS E-M AMPLI-SPEED DRIVE



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Minneapolis 13, Minnesota

Technical briefs

Begins on page 92

objective and nosepiece threads; surveying-instrument mounting threads; class-5 interference-fit threads, trial standard and wrench openings. *Price 60¢.*

Also available are Parts I and II previously published. Part I covers screw threads for bolts, screws, nuts and similar fastenings. They are variously designated as unified, American, national and unified miniature threads. *Price $1.25.*

Part II covers standards for pipe threads including dry-seal threads, gas-cylinder-valve-outlet and -inlet threads; hose couplings including fire-hose-coupling threads and hose connections for welding and cutting equipment. *Price 75¢.*

Water

Industrial water conservation and re-use, *R D Hoak, Mellon Institute*

Some estimates of water consumption show current use at about 231 bgd in the U.S. vs 650 bgd as the average maximum available. With anticipated national growth added in, this 231 bgd increases alarmingly. But there is a fallacy here. Some assume that use and consumption are synonymous; actually they are not.

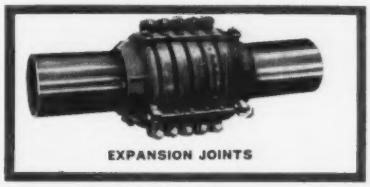
When consumption only is considered, this figure drops to about 72 bgd, a far cry from average water availability. Nevertheless we know that acute water shortages do exist, and this points up another fallacy—using *average* values for determining water consumption and availability.

In water-shortage areas conservation is essential to sustained industrial operation. And even in areas of abundance, water conservation has many times proved economically attractive. The pulp and paper industry's record of water conservation exceeds the national average. But even greater efficiency of water use here and elsewhere in industry is needed to permit orderly, economic industrial expansion, especially where water supplies are chronically critical. *TAPPI, Oct 1960*

continued

◀ circle 251 on Reader Service card, p 101

51 SOLUTIONS TO PIPE MOTION PROBLEMS



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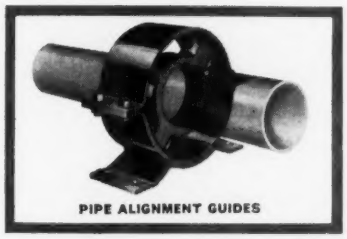

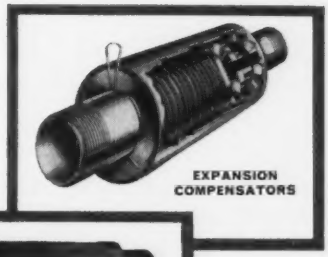

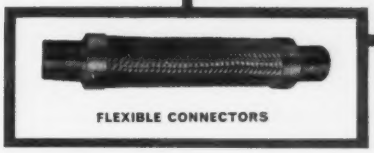

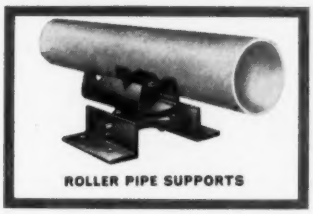

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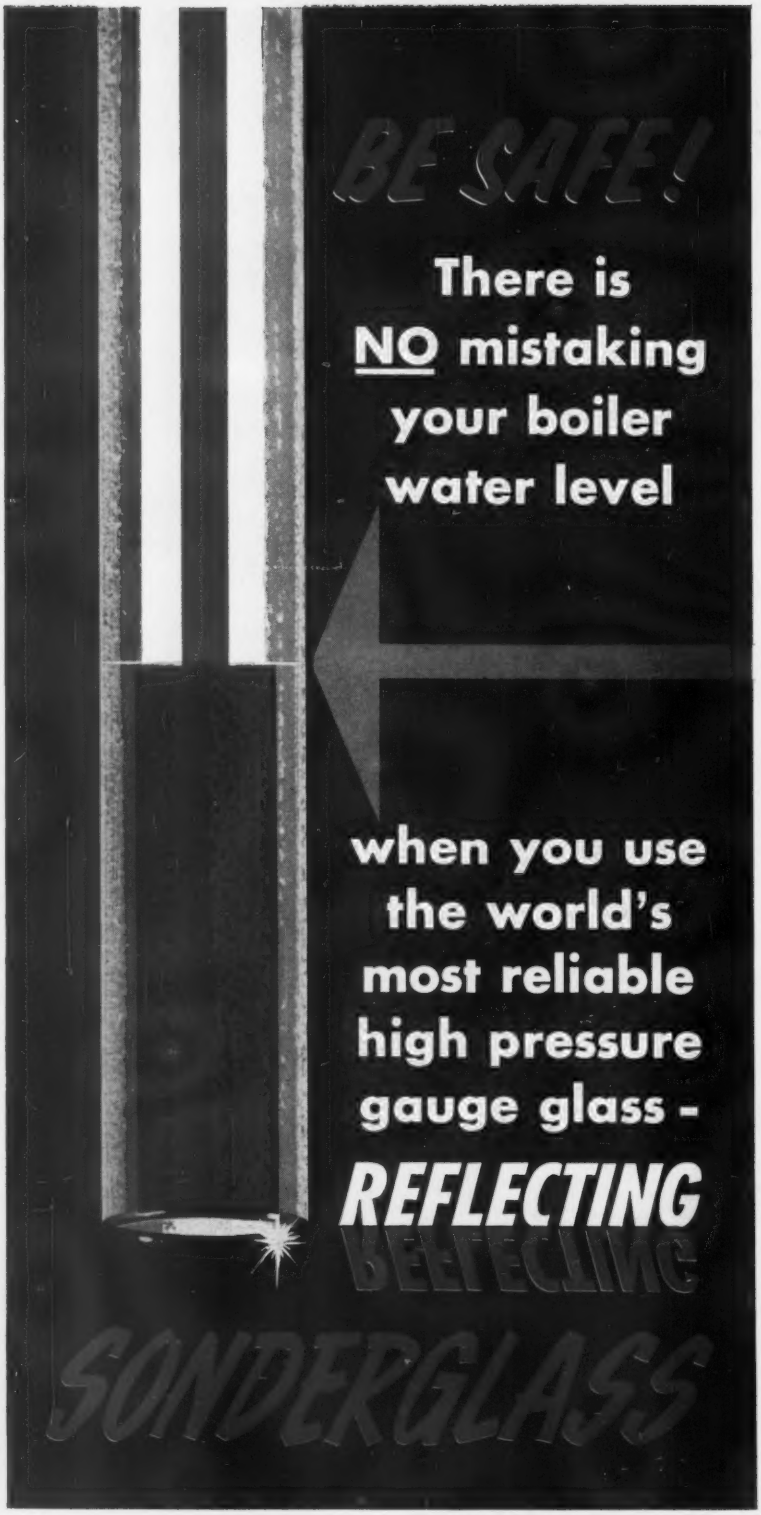

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A. W. CHESTERTON CO., Everett 49, Massachusetts

Technical briefs

Begins on page 92

Water treatment for high-makeup boilers operating in the range of 600-1250 lb, *Leonard Limon, Graver Water Conditioning Company*
Several basic water-treatment methods meet needs of industrial power plants operating in the pressure range of 600 to 1250 psig. These include: (1) sodium-zeolite or sodium-hydrogen-zeolite softeners (2) desilicizers (3) hot-process hot-zeolite softeners and (4) demineralizers. To be meaningful, any evaluation of these various methods must include studies of operating costs (chemical and labor), installed equipment costs, space needs and effects on boiler and turbine operation.

Typical low-, medium- and high-solids plants are discussed, showing how to approach proper water-treatment-plant selection. In addition, certain specific plants illustrate the evaluation process.

Latest improvements in central-station water-treatment design—condensate scavenging—illustrate benefits of condensate filtration. Benefits can hold good for some lower-pressure-unit operators, too—especially those with high makeup problems. *TAPPI, Oct 1960*

To obtain complete text

Material for these abstracts comes from the following sources. Order complete publication from source, *not* POWER.

ASME. Contact American Society of Mechanical Engineers, 29 W 39th St, New York 18, N.Y. Members, 50¢; nonmembers, $1.00.

Pipe Fabrication Institute, Suite 759, One Gateway Center, Pittsburgh 22, Pa. No charge for standards and bulletins, *except:* for more than one copy of TB1-1960, include $2.00 per copy.

National Bureau of Standards, U.S. Dept of Commerce, Washington 25, D.C. Prices as indicated.

WRB, Contact Director, Water Resources Branch, Dept of Northern Affairs and National Resources, Ottawa, Canada. No charge.

TAPPI. Papers will appear in *TAPPI Magazine.* Contact Technical Association, Pulp and Paper Industry, 360 Lexington Ave, New York 17, N. Y.

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1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75
76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

NEW LITERATURE listed in this issue, starting on p **101A**

101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125
126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150
151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175
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ADVERTISED PRODUCTS appearing throughout the issue

201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225
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SEARCHLIGHT SECTION for used and rebuilt equipment, starting on p **205**

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New free literature

General equipment and key materials for systems engineering

101 **Diesel engines** in 100- to 210-hp class are charted and illustrated in 4-p catalog BU-718. Cutaways of important components are included. Allis-Chalmers Mfg Company, Engine-Material Handling Div

• **Instruments**

102 **Dual-channel recorder** provides two channels of input which simultaneously record full scale. Unit, subject of 2-p spec sheet, ranges from 10 mv to 100 v, from 1 microamp to 10 ma. Yellow Springs Instrument Co

103 **Potentiometer** with new rebalancing element is subject of 24-p catalog. Modular construction is illustrated with specs on three basic models: strip- and circular-chart recorders, circular-scale indicator. Minneapolis-Honeywell Regulator Company

104 **Controllers,** recorders, indicators, circular-chart, strip-chart, circular-scale series, are subjects of spec sheets S 172-1 and -2, S 173-1 and -2, S 176-1 and -2. Calibrations and spans are given. Minneapolis - Honeywell Regulator Company

105 **Transducer** for controlling position, tension, speed and weight is subject of technical summary. Applications, operating principles and design considerations are described. Electric Regulator Corp

106 **Chart and ink** 28-p catalog G-100-6 describes features of paper and ink used, lists most common charts. Minneapolis - Honeywell Regulator Company

• **Lubrication**

107 **100-kv X-ray spectrograph** is subject of 4-p reprint. Article shows how manufacturer uses X-ray analytical methods on lubricating oils, crudes, residuals. Philips Electronic Instruments

108 **Lever guns** are subject of data sheet 732. Guns are set to handle lube cartridges and dispense bulk grease. H-p operation—up to 10,000-psi grease pressure. Lincoln Engineering Company

• **Maintenance**

109 **Two wall charts** compare traits of various flames, give welding- and cutting-flame illustrations. Smith Welding Equipment Corporation

110 **H-t mortar** for boiler brickwork installation and repair is feature of bulletin 602. Temperatures and amount needed for trowelling, dripping and brushing are included. J H France Refractories Company

111 **Wire rope** with seven strands laid around core is subject of 4-p

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folder 60100. Combines flexibility with fatigue resistance. Macwhyte Wire Rope Company

112 **Nondestructive-testing** equipment is described in 12-p bulletin 00-105. Application, specs for portable X-ray and magnetic-particle inspection equipment are included. Sperry Products Company

113 **Alkaline cleaner** to remove burned-on oil and clean tanks is topic of circular 17B. Cleaner can be used on steel, iron, brass and magnesium. Oakite Products, Inc

114 **Rust prevention** and removal are detailed in bulletin 16B: removing rust from raw stock with inhibitors, preventing rusting between processing operations. Oakite Products, Inc

• Pipings, valves and specialties

115 **H-p motor valves** for pressures up to 6000 psi are subject of data sheet. Specs and prices are features. Instruments, Inc

116 **Forged naval-bronze ball valve,** described in 4-p folder DH-38, can be used for water, oil and gas service. Materials and dimensions spec table is included. R-P&C Valve Div, American Chain & Cable Company, Inc

117 **H-p h-t cast-steel gate** and globe valves with reduced operating torque and positive shutoff are explained in 6-p bulletin. Primarily for steam-generating plants, valves also are said to have wide industrial application. Walworth Company

118 **Screwed-end plug valves** for instrument and process piping are diagramed in 4-p brochure D-1. Valves provide bubbletight closure, corrosion resistance. Continental Manufacturing Co

119 **Corrosion-resistant** valves are illustrated in 16-p bulletin 7. Alloy materials, chemical composition, ranges are listed. Alloy Steel Products Company

120 **Degree indicator** for pipe bending eliminates spoilage by automatically measuring degree of bend as it is made. Steps are illustrated and described in 8-p bulletin E-301 from Greenlee Tool Co

121 **Sight-flow indicators** feature rotatable flanges—described in design sheet DS-820. Brooks Instrument Company, Inc

122 **Exhaust heads** to remove impurities from steam being discharged are subject of form AD-2438. Crane Company

123 **Cleaner-snubber** is used in place of separate air-intake filters for reciprocating compressors, blowers, gas or diesel engines. Unit works in municipal power plants, gas-transmission systems. See 6-p bulletin from Burgess-Manning Co, Industrial Silencer Div

continued

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NEW LITERATURE listed in this issue, starting on p 101A

101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125
126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150
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Air-conditioning systems

• Refrigeration

124 **Principles** of refrigeration, air-conditioning equipment are features of 32-p bulletin 80-F. A table of storage temperatures is included. Frick Company

125 **Liquid chiller,** hermetically packaged, is described in 10-p illustrated bulletin 3926. Rated capacity tabulations and cooler and condenser pressure-drop charts are features. American-Standard Industrial Div

126 **Refrigeration equipment** is detailed with specs, capacities, accessories and tables for coolers, freezers and hardening rooms in 16-p catalog from McQuay, Inc

127 **Cryogenic-service steel** to contain liquefied-gas cargoes is subject of 27-p reprint. Presents data sheets for various types of nickel steels and stainless steels. The International Nickel Company, Inc

• Ventilation

128 **Portable air purifier** uses the principle of forcing air through activated carbon—topic of 4-p pamphlet. Roark Industries, Inc

129 **Catalyst-exhaust purifier** for fume reduction is described in 4-p folder. Case histories of purifier installations on industrial vehicles are presented. Oxy-Catalyst, Inc

130 **Pressure drop** within asbestos-cement air ducts is the subject of 4-p reprint. Article describes results of tests—basis for charts giving friction losses in in. H_2O per 100 ft. Johns-Manville Corp, Pipe Div

131 **Vapor inverters** direct storage-tank fumes and gases high into air to protect personnel. Data sheet 100-37-0 gives details. The Johnston & Jennings Co

132 **"Electric eye"** unit guards against smoke circulated by an air-conditioning system. Exact density of gases is visible on meter. Details in bulletin 553 from Photomation, Inc

Electrical systems

• Distribution and protection

133 **Outdoor oil circuit breakers** feature cross-blast interrupter to reduce arcing time, cut carbon and oil contamination; available in ratings of 23 to 46 kv, 500 to 1500 mva. See bulletin 71B8475 available from the Allis-Chalmers Mfg Company

134 **Compact substation** 6-p folder 61B9756 lists unitized components. Structural members are punched so additional high- and low-volt-

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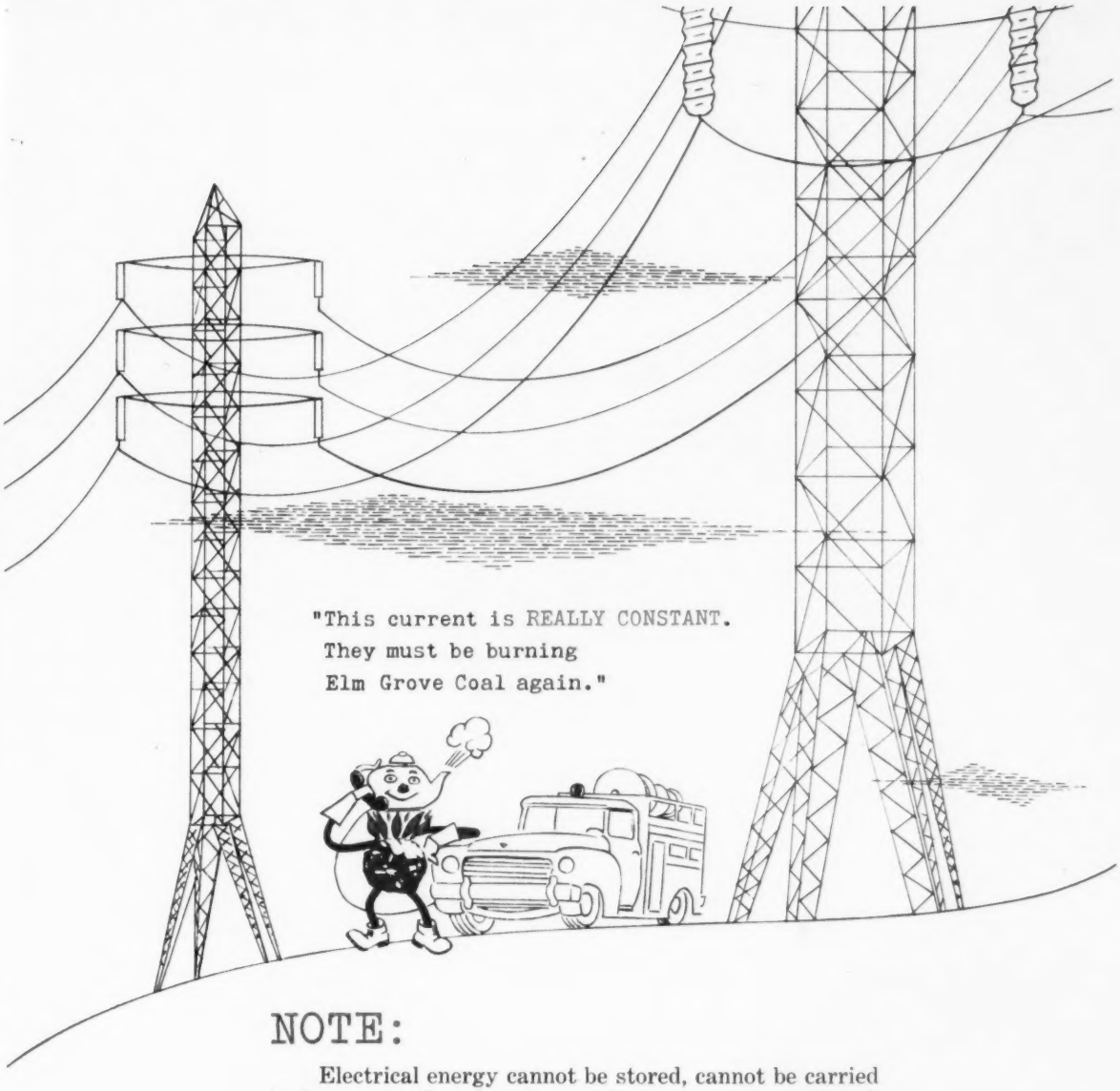

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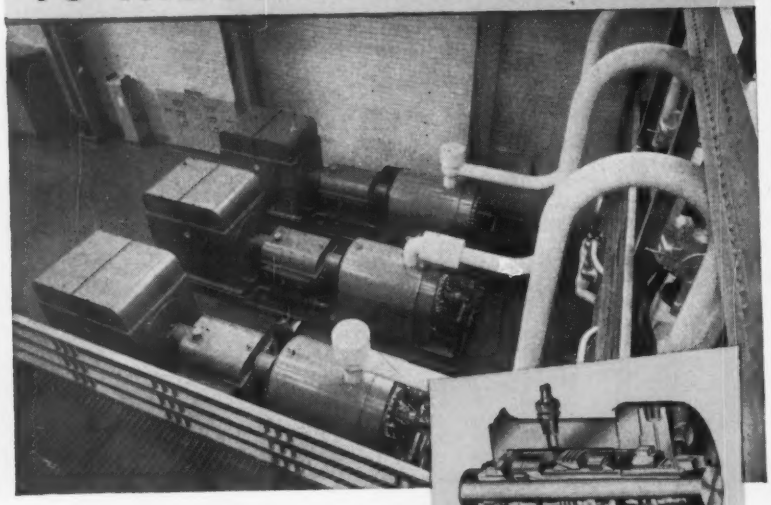
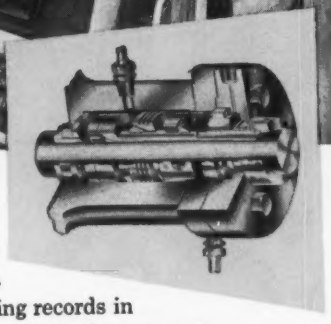
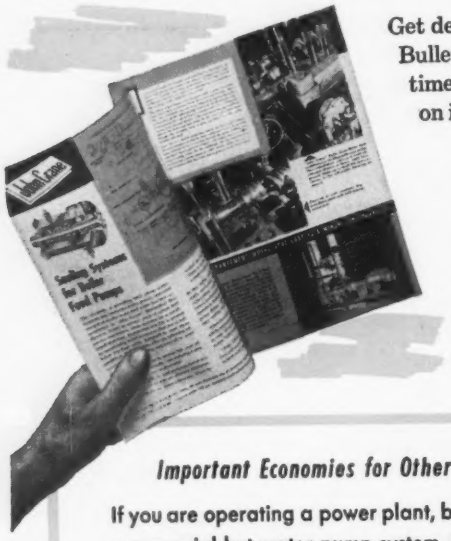
John Crane

BOILER FEED PUMP SEALS are BRINGING NEW ECONOMY TO INDUSTRY and UTILITIES





It will be worth your while to get full information about "John Crane" Seals for your high temperature, high pressure boiler feed pumps. At numerous installations they are setting records in the saving of maintenance, feed water and kilowatt costs.



Get detailed data by requesting our Bulletin S-230. At the same time we will give facts and figures on installations now in operation.

On letterhead request, we will furnish a complete layout to meet your pump requirements. Give us make, model and serial number of your pump, plus temperatures, suction and discharge pressures.

Important Economies for Other Hot Water Service, Too!

If you are operating a power plant, boiler room, industrial or commercial hot water pump system, Bulletin S-230 can help you. Contents include full details on hot water shaft seals that offer the same cost savings as boiler pump feed seals.

Crane Packing Company, 6430 Oakton Street, Morton Grove, Ill., (Chicago Suburb). *In Canada: Crane Packing Co., Ltd., Hamilton, Ont.*

MECHANICAL PACKINGS SHAFT SEALS TEFLON PRODUCTS LAPPING MACHINES THREAD COMPOUNDS

CRANE PACKING COMPANY

Free literature

Begins on page 101A

age bays can be bolted on. Allis-Chalmers Mfg Company

135 **Dry type** integral distribution centers are discussed in 20-p catalog GEA-6928A. Centers for applications up to 5000 v are illustrated with ratings, dimensions, weights and list prices. General Electric Company

136 **L-v distribution** equipment is covered in 92-p buying catalog GEC-1100C. Provides specs on heavy-duty safety switches, current-limiting fuses, circuit breakers, motor-control and power-distribution centers, panelboards and busway. General Electric Company

• **Application**

137 **Coated glass fabrics** for electrical applications are illustrated in 6-p folder. Some applications: heavy-duty-transformer and motor-end-turn coil insulation. Irvington Div, Minnesota Mining and Mfg Co

138 **Control center** for semiconductor work where production and lab procedures are involved is feature of spec sheet from Barber-Colman Co, Wheelco Industrial Instruments Div

139 **Transmission** with electric shift is outlined in 2-p catalog. Electromagnetic clutches change speed and reverse under power without interrupting power source. Western Manufacturing Company

140 **Ac motors,** fractional-horsepower, shaded-pole and permanent-split-capacitor units, are the subject of a 4-p folder. Ratings are for 60-c 115-v operation. Leece-Neville Company

141 **Door interlocks** featuring maintained-contact actuator position for checking electrical equipment are announced in data sheet 178. Minneapolis-Honeywell Regulator Company

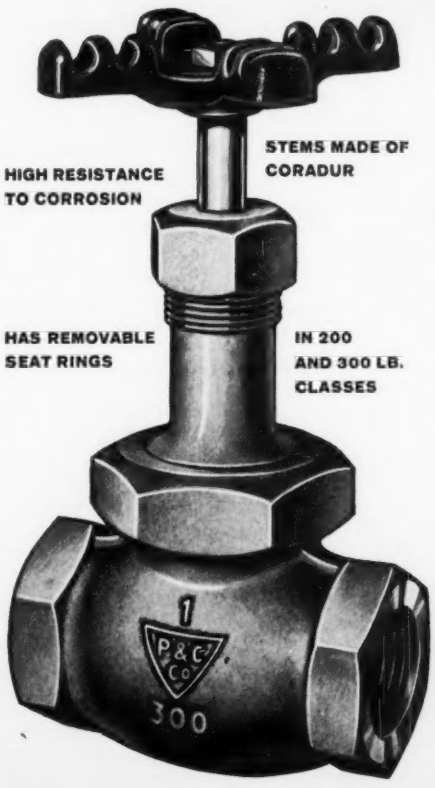
142 **General-purpose relays** also cope with severe changes in temperature and humidity—4-p pamphlet gives details. Artisan Electronics Corp

143 **Power-conversion** 16-p guide compares static and rotating electrical devices. Hamilton Standard

144 **Time-delay relays** with printed-circuit construction in a timing range of 100 millisec to 60 sec are topic of 6-p bulletin from Leach Corp

145 **Color-coded kits** for modifying firm's control relays are covered in publication PL 12-35-960. Shows 24 different relay-pole kits with types of contacts for any

"R-P&C Bronze Valves keep performing like new"



"Valves, like any vital piece of plant equipment, must be kept in top working order at all times. And with R-P&C Bronze Gate and Globe Valves this is no problem, for these valves have **renewable seat rings.** Made of durable 500 Brinell Stainless Steel, or Copper Nickel, seat rings can be screwed in or out if replacement is necessary. Moreover, when servicing is required, the union bonnet permits fast, easy access to internal parts."

The **stems** of R-P&C Bronze Valves are made of special Aluminum Silicon Bronze (**CORADUR**) to afford high resistance to corrosion and seizure. Their **full plug** design makes them ideally suited for throttling in steam, water, oil and/or gas service. Air-cooled, **cross-type handle** gives added ease of operation.

These features, and many others, are available with R-P&C Bronze Gate and Globe Valves in the 200 and 300 pound classes.

Contact your R-P&C distributor for complete information about these valves as well as R-P&C's complete line of electric furnace iron, cast steel, bar stock and forged steel valves.

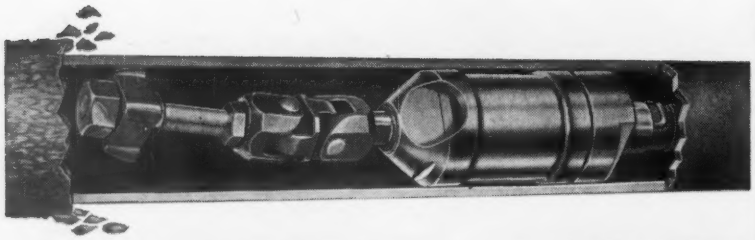
R-P&C VALVES

ACCO

R-P&C Valve Division, American Chain & Cable Company, Inc.

Reading, Pa., Atlanta, Boston, Chicago, Denver, Detroit, Houston, New York, Philadelphia, Pittsburgh, San Francisco, Bridgeport, Conn.

For more facts circle 256 on Reader Service card, p 101



ROTOJET®

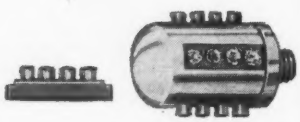
Cleans Fire Tubes ▸▸▸▸▸▸ FAST ▸▸▸▸▸▸▸ INSIDE and OUTSIDE

You can now clean fire tubes inside as well as outside faster with a new Rotojet. The new Rotojet is the most powerful tube cleaner we ever built. It won't stall at low speeds caused by heavy loads. Roto expanding heads and brushes thoroughly clean soot scale inside tubes. A Roto vibrating head (illustrated above) knocks off water scale adhering on the outside.

Try the new Rotojet, and no other tube cleaner will ever satisfy you.

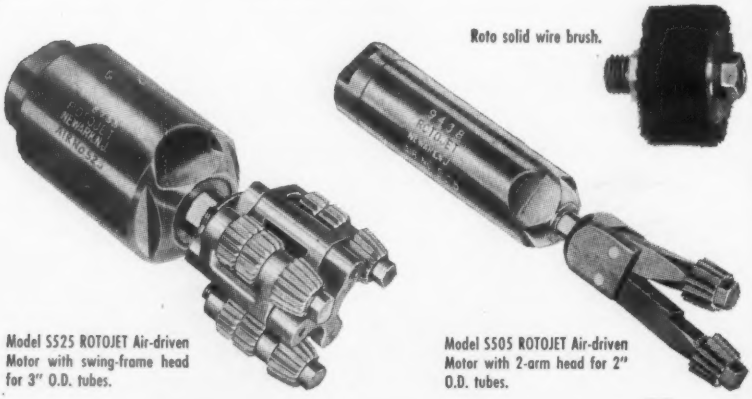
Economical Roto Brushes

Roto expanding brushes and heads have separately replaceable wearing elements. These inexpensive parts save time, money, and critical materials. Send for details.



Roto expanding brush, showing a replaceable brush element. Brings down tube cleaning cost. Maintains high cleaning efficiency.

Roto solid wire brush.



Model SS25 ROTOJET Air-driven Motor with swing-frame head for 3" O.D. tubes.

Model SS05 ROTOJET Air-driven Motor with 2-arm head for 2" O.D. tubes.

ELLIOTT COMPANY – ROTO PLANT
Tube Cleaner Specialists Since 1910
1071-53 Bristol Road, Mountainside, N. J.

For more facts circle 257 on Reader Service card, p 101

Free literature

Begins on page 101A

application. Eight pages include diagrams showing where to use kits on mounting plates. Clark Controller Company

146 **Mercury-vapor lamps** are covered in 28-p booklet. Manual includes light output, life ratings, necessary auxiliary equipment. Westinghouse Electric Corp

Fluid-handling systems

- **Pumps**

147 **Power-driven** variable-capacity hand- and truck-mounted, and liquefied-gas pumps are pictured and described in 8-p bulletin from Blackmer Pump Company

148 **Cost** of stuffing-box leakage and methods to overcome this are subject of 4-p circular. Daily and yearly leakage costs based on value of liquid metered are charted. Lapp Insulator Company, Process Equipment Div

Mechanical transmission systems

149 **Shaft-** and flange-mounted drives with torque range up to 44,000 lb-in. are explained in revised 36-p catalog 7100. Included are predrilled steel motor mounts. The Falk Corporation

150 **Flat-belt pulleys** in face widths from 2½ to 12 in. and OD from 4 to 36 in. are subject of 4-p pamphlet 22103. T B Wood's Sons Co

151 **V-belts** are detailed in 8-p brochure M-201. Included are specs and ordering info. Raybestos-Manhattan, Inc, Manhattan Rubber Div

152 **Timing-belt drives** for load capacities to 600 hp and belt speeds to 16,000 fpm are subject of 50-p catalog 19103. Charts provide graphic selection of proper pitch, drive width and belt pitch length. T B Wood's Sons Co

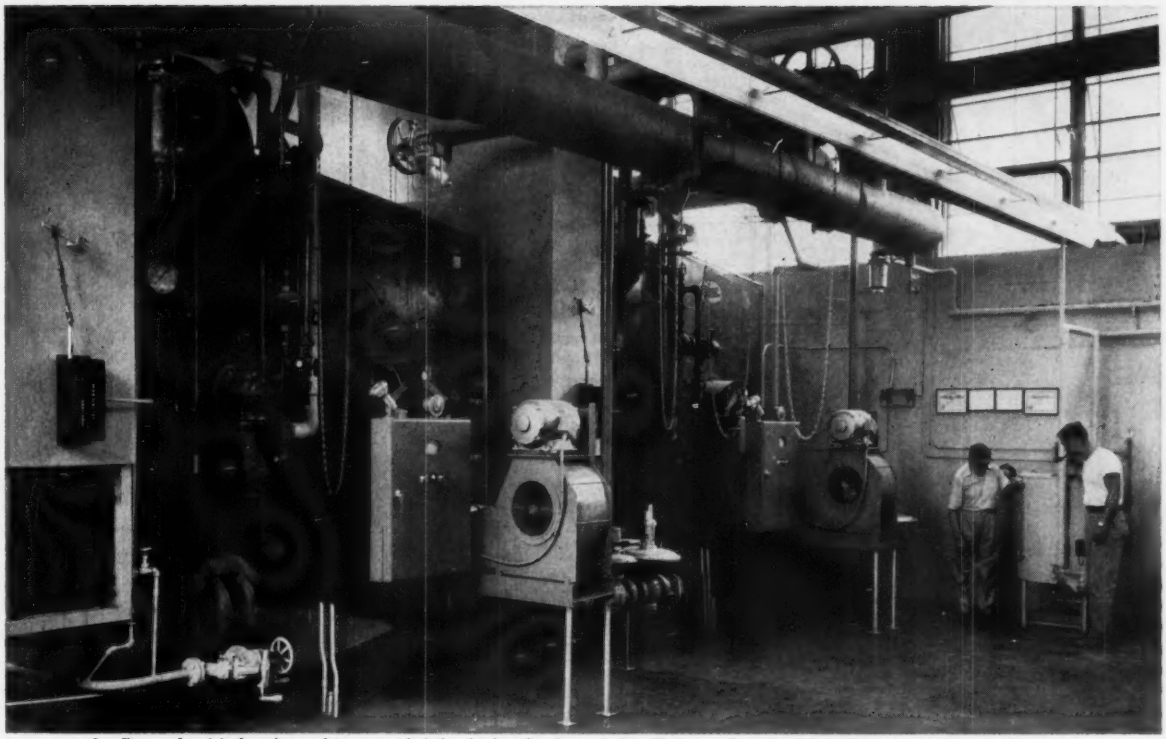
153 **Wide inner ball bearings** and power-transmission units are topics of 60-p booklet. Bearings are easily mounted on straight shafts without shoulders or adapters. The Fafnir Bearing Company

Steam systems

154 **H-p packaged boilers** are outlined in data sheet. Only a small vent is needed to carry off spent gases. Western Boiler Company

155 **Operation** and control of high steam temperatures are diagramed in 4-p folder 543. Curves show effects of control. Bailey Meter Company

continued



Iron Fireman forced draft gas burners firing water tube boilers that heat three large schools in Washington Township, Toledo, Ohio. Architect-Engineer: McLaughlin and Keil, Lima, Ohio. Mechanical Contractor: Johnson Plumbing & Heating Co., Toledo, Ohio. Iron Fireman Dealer: Stoker Sales & Service Co., Toledo, Ohio.

Iron Fireman forced draft firing of water tube boilers gives top performance

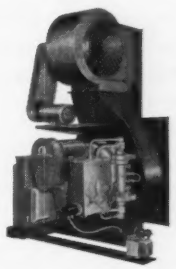
with gas, oil or gas-oil combination

Complete firing system can be bolted to boiler front — no major alteration

The Iron Fireman units shown above are complete fuel burning systems designed specifically for firing water tube steam generators. Each burner provides forced draft firing for 24,000 lb. steam per hour. This Iron Fireman burner has been selected by many boiler design engineers to fire their modern sealed, high output boilers because it provides its own forced draft, requires no stack or induced draft fan. It includes its own air register, pre-wired control system, and is completely assembled and tested at the factory. Performance and costs are accurately predictable. Backed by the largest group of fuel burning specialists in the United States and Canada.

Iron Fireman equipment cuts your installation costs substantially. In addition, you have a *unit* that has been factory engineered and carefully built for exceptional efficiency and reliability. Backed by a nation-wide service organization.

Mr. O. K. Benton of the Washington Township Board of Education, writes: "For most of last season we ran this equipment 24 hours a day, 7 days a week. Operation has been very satisfactory, with plenty of reserve power for the coldest days."



A factory engineered package

Everything required to generate heat with exceptional efficiency and economy is engineered into this compact package — factory built, factory wired, factory tested. Easy to specify, easy to to install, easy to operate and easy to maintain.

For full information please mail the coupon below

IRON FIREMAN

HEATING AND AIR CONDITIONING
AIRCRAFT COMPONENTS AND EQUIPMENT
MISSILE AND AIRCRAFT GYROSCOPES
ELECTRONIC EQUIPMENT
CONTROL INSTRUMENTS

Iron Fireman Mfg. Co., 3155 W. 106th St., Cleveland 11, Ohio
(In Canada, 80 Ward St., Toronto)

Please send full information and specifications on the burner for firing Water Tube Boilers.

Name_____

Firm_____

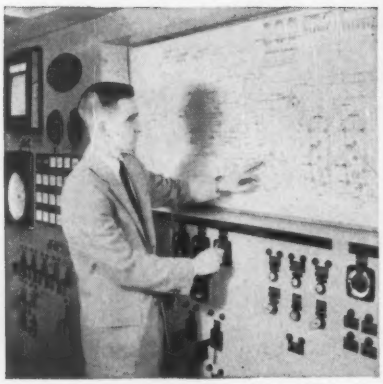
Address_____

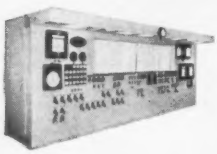
City_____ State or Prov._____

For more facts circle 258 on Reader Service card, p 101

METROPOLITAN EDISON uses...

ILLCO-WAY ionXchange





This graphic control panel, designed and built by IWT, not only has all the controls but also a schematic diagram with indicating lights to show the action at all points.

Blowdown Unnecessary in a New High-Pressure Once-Through Boiler

The Portland Station of Metropolitan Edison Company at Portland, Pa., has a once-through type of boiler for which the purity of make-up water is particularly critical. IWT Mixed-Bed* De-Ionizers were selected to purify the make-up water to the required degree — and they succeeded, even beyond expectations. The total silica in the boiler water is consistently maintained at 0.1 ppm or less. From the Mixed-Bed* De-Ionizer, the silica is normally below 0.01 ppm and log sheets frequently show analyses as low as 0.003 and 0.005 ppm. With such a high purity of make-up water, blow-down is entirely unnecessary for extended periods of time. All IWT equipment — including chemical feeders, gravity filters, cation and anion exchangers, a vacuum degasifier, and the Mixed-Bed* De-Ionizers — are controlled *automatically* from the graphic panel shown above.

*U.S. Pat. Nos. 2,605,084, 2,771,424

PIONEERING EXPERIENCE

Such outstanding performance is the result of intensive early and continuing experience, by Illinois Water Treatment Co., with the special problems of ion-Xchange. *To benefit from this leadership, call your IWT representative.*

ILLINOIS WATER TREATMENT CO.
840 CEDAR ST., ROCKFORD, ILLINOIS
NEW YORK OFFICE: 141 E. 44th St., New York 17, N.Y.
CANADIAN DIST.: Pumps & Softeners, Ltd., London, Ont.

Circle 259 on Reader Service card, p 101

Free literature

Begins on page 101A

- **Fuel handling**

156 **Safety system** for plants using gas is described in 12-p supplemental bulletin 22. Safety-shutoff valves and supervising gas cocks are mainsprings of this system which is also applicable in fuel-oil-using plant. The North American Manufacturing Company

157 **Wet drum** separators available in concurrent and counter-rotation styles are topic of 4-p circular. Stearns Magnetic Products

158 **Valve** that connects gas line to burner incorporates long shaft for quick, leaktight connections; subject of catalog from Mechanical Products Corporation

Energy-systems services

159 **Design engineering** and consulting services are outlined in 32-p book. Illustrations show progress in planning and design for electric-power generation and transmission. Commonwealth Associates, Inc

160 **Automatic-control-system** manufacturer offers 24-p illustrated brochure featuring products and research, development and manufacturing services. CompuDyne Corp

EDITOR'S NOTE: *The following bulletins may be requested directly from the manufacturer. Write on company letterhead to addresses listed below:*

★ **Condenser-tube handbook** discusses corrosion problems in the oil, utility, marine, chemical and sugar-refining industries. Available from Chase Brass and Copper Co, Waterbury 20, Conn.

★ **Semiconductor rectifiers** are described in 24-p short-form catalog from International Rectifier Corp, 1521 E Grand Ave, El Segundo, Calif.

★ **Centrifugal pumps** with ranges from −350 to +1000 F and up to 1000 psig are topic of 12-p selection catalog. Includes specifications and charts showing recommended temperatures and pressures. Dean Brothers Pumps Inc, 323 W 10th St, Indianapolis 7, Ind.

★ **Electrical-indicating** panel instruments are covered in 24-p catalog available to engineering personnel. Space on miniature and full-size units from ½- to 4½-in. dia are included. Electric Sales Div, DeJur-Amsco Corporation, 45-01 Northern Boulevard, Long Island City 1, N. Y.

ANOTHER NEW ACHIEVEMENT IN MODERN FLOW CONTROL BY CRANE

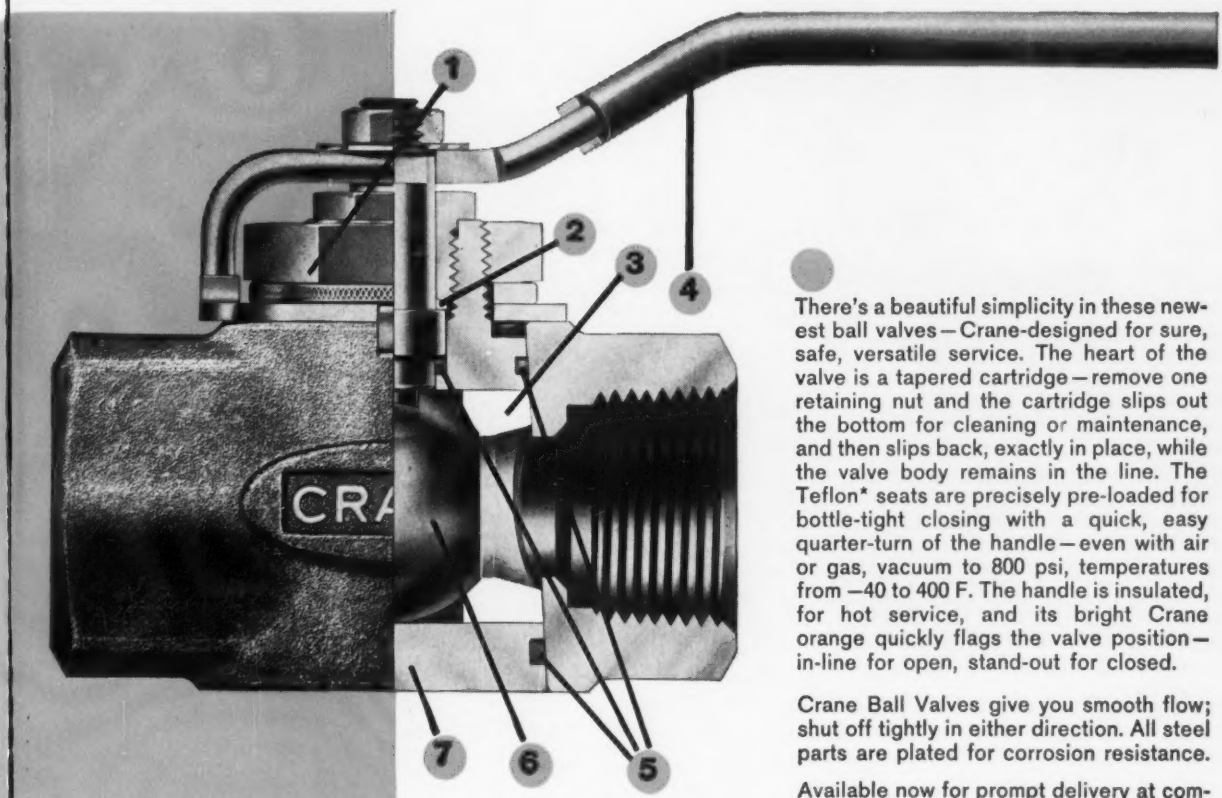
1. Single retaining nut holds cartridge assembly in body, for fast, foolproof dismantling and assembly
2. Teflon* thrust washer reduces stem friction; absorbs line pressure load on ball
3. Teflon* seats pre-loaded for tight shut-off with minimum torque
4. Bright plastic grip insulates handle and flags valve position
5. Positive, Standard Size O-ring seals on stem, cartridge
6. Self-aligning, precision-machined ball, polished and chrome-plated to minimize friction and wear on seats.
7. Tapered cartridge contains all working parts; slips out bottom in one piece for cleaning or maintenance

* Teflon is a registered trademark of E.I. DuPont de Nemours & Co., Inc.

CRANE BALL VALVES

with the exclusive tapered cartridge that drops out for fast, in-line servicing

designed to handle all air and water services to 400 F



There's a beautiful simplicity in these newest ball valves—Crane-designed for sure, safe, versatile service. The heart of the valve is a tapered cartridge—remove one retaining nut and the cartridge slips out the bottom for cleaning or maintenance, and then slips back, exactly in place, while the valve body remains in the line. The Teflon* seats are precisely pre-loaded for bottle-tight closing with a quick, easy quarter-turn of the handle—even with air or gas, vacuum to 800 psi, temperatures from —40 to 400 F. The handle is insulated, for hot service, and its bright Crane orange quickly flags the valve position—in-line for open, stand-out for closed.

Crane Ball Valves give you smooth flow; shut off tightly in either direction. All steel parts are plated for corrosion resistance.

Available now for prompt delivery at competitive prices—sizes from ¼" to 2", screwed ends, in bronze, steel and Type 316 stainless.

Call your Crane Distributor or send today for a complete, illustrated folder on the outstanding new Crane Ball Valves, engineered for unmatched service.

CRANE

CRANE CO. Industrial Products Group
4100 South Kedzie Ave., Chicago 32, Ill.
In Canada, Crane Ltd., 1170 Beaver Hall Square, Montreal

Valves/Electronic Controls/Piping/Plumbing/Heating/Air Conditioning

How to step up the output of your air tools

Are you wasting valuable production man-hours with a weak compressed air system? Here's how to make *sure* you get top output with air tools . . .

The experienced application engineers of Cooper-Bessemer and Rotor Tool will help you analyze your entire air system. This study includes compressor capacity needs, compressor location for greatest operating economy, air pressure regulation, the distribution system and portable tools. There is no obligation.

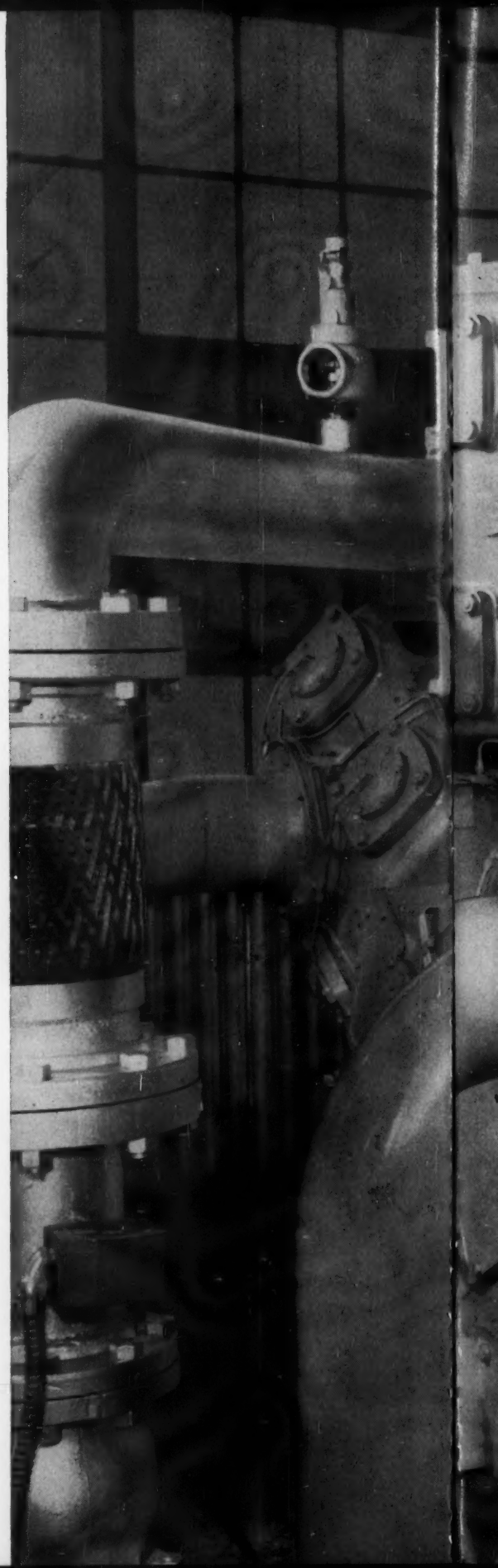
Call the nearest Cooper-Bessemer or Rotor Tool office.

BRANCH OFFICES: Grove City • New York • Washington Gloucester • Pittsburgh • Detroit • Chicago • Minneapolis • St. Louis Kansas City • Tulsa • New Orleans • Shreveport • Houston Greggton • Dallas • Odessa • Pampa • Casper • Seattle San Francisco • Los Angeles • *SUBSIDIARIES:* Cooper-Bessemer of Canada, Ltd. . . . Edmonton • Calgary • Toronto • Halifax Stratford • C-B Southern, Inc. . . . Houston • Cooper-Bessemer International Corporation . . . New York • Caracas • Anaco Cooper-Bessemer, S.A. . . . Chur, Switzerland • The Hague, Netherlands • Mexico City • The Rotor Tool Company, Cleveland

Cooper Bessemer

GENERAL OFFICES: MOUNT VERNON, OHIO

ENGINES: GAS - DIESEL - GAS-DIESEL
COMPRESSORS: RECIPROCATING AND CENTRIFUGAL
ENGINE, TURBINE OR MOTOR DRIVEN



For more facts circle 261 on Reader Service card, p 101

NEW COOPER-BESSEMER DMR-3 AIR COMPRESSOR in foundry service. This highly compact 720 rpm compressor can be located strategically near the work area to reduce installation costs and help assure peak tool performance. Available for 572 to 2000 cfm and discharge pressures of 80 to 125 psig. Full details in Bulletin No. 94.

For more data on these developments, circle key numbers on Reader Service card, p 101

Plant equipment news... Your

Strain-gage-balance "pot" achieves infinite resolution

1 • New industrial-process potentiometer has an electromechanical strain gage, left, to replace conventional slidewire balancing element. For the first time, resolution—the number of points at which a potentiometer can come to balance—is infinite. Four looped-wire strands form variable-resistance legs of a measuring circuit; their resistance varies in proportion to tension. Previous pots could have only as many balance points as the slidewire had convolutions, limiting precision of measurements.

Initial production of the ElectroniK 17 began in February. Pen-strip and circular-chart recorders and a circular-scale indicator are first models. They mount on a 19-in. relay rack, a panel or bench, or they're portable.

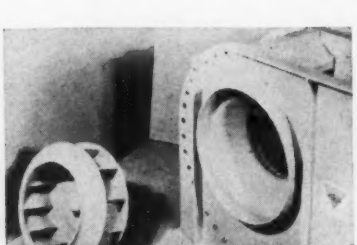
Other features of the basic pot: all critical components are electrically shielded to reject stray signals, avoid recording errors. Transistorized plug-in control units provide a maximum eight set points for auxiliary or zone control. They're supplied as original equipment in any combination or you can modify to suit in your own plant.—Minneapolis-Honeywell Regulator Company

Fume and mist collector

2 • A 3-stage separator and filter system is heart of this collector. Cyclonic action first separates 98% of the mist. Part is dried, the rest collects in a plastic receptacle.

Remaining 2% mist goes through a filter cartridge made up of fiberglass and activated-carbon layers which collect by impingement and adsorption. Filter element can be removed, recharged, then replaced.

Three standard models cost $220, $320 and $440, range from 350 to 1200 cfm. You can hang them from the ceiling.—Chicago Air Filter Co



Reinforced plastic blowers

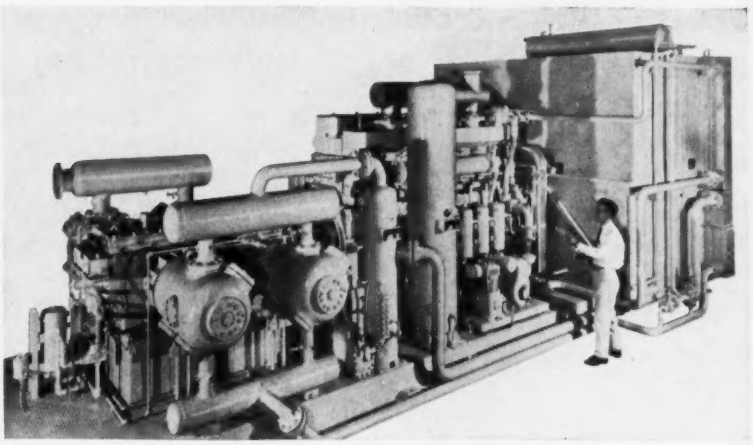
3 • Duracor-reinforced-plastic centrifugal-blower housings and Duracor-covered standard fan wheels combine chemical resistance with high strength-to-weight ratios. Housings are corrosionproof throughout for maximum resistance to attack from most acids, alkalis and fumes.

Unit above handles 12,000 cfm of free chlorine fumes at temperatures to 250 F. Various Duracor resins meet individual operating problems. New units can be installed as separate components in your existing system.—The Ceilcote Company

Gas and fume disposal

4 • Vapor inverter mounts on pressure-relief vent of a storage tank. Fumes and gases vented as product is pumped in are directed high into the air, protecting personnel in nearby ground areas. Inverter directs 80% or more of the vented fumes into the air at velocities from 13 to 25 mph.

Units don't cut capacity of the relief vents, maker states. They work efficiently even when it's snowing because they diffuse the snow; bottom holes let rain water drain away. Sizes range from 2 to 12 in.—The Johnston & Jennings Co



Medium-speed compressors drive direct

5 • Balanced-opposed 2- and 4-cylinder compressors are engineered for direct drive with the company's natural-gas engines. Design provides continuous, unattended heavy-duty service gathering gas, lifting, repressuring and boosting. There are now 300,000-hp worth of the engines running, maker states; compressor features same simple construction and design.

Matched engine-compressor sets operate at 600 to 900 rpm. Compressor uses a 6-in. stroke; the 2-cylinder compressor is rated from 200 to 635 bhp, 4-cylinder model up to 1000 bhp. Standard cylinders in 68 sizes mount interchangeably. They range from 2⅝-in. dia, 4000 psi to 22½-in. dia, 85 psi.—White Diesel Engine Div, White Motor Company

Vibration pad is prescored for on-the-job cutting

6 • Vibration-isolation pads use specially processed high-density fiberglass. Elasticity of the glass fibers combines isolation efficiency with internal damping. Chatter caused by externally excited vibration is eliminated in precision machines.

Pads come in 18x18x12-in. sheet, prescored at 2-in. intervals so they can be cut to size easily, right on the job and with a penknife if necessary. Your maintenance men can install them without cementing, sawing, floor drilling—or waiting.

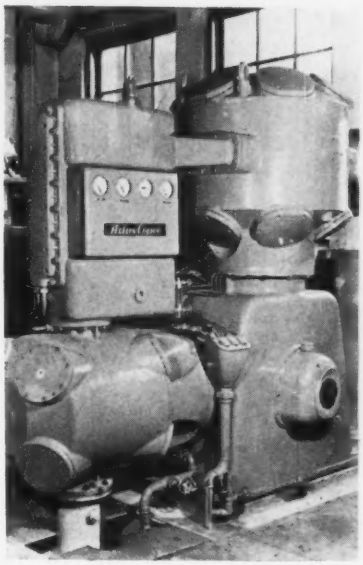
Since pads are guaranteed not to creep, maker suggests you needn't lag production machinery to the floor, but can move it to follow the work flow.—Consolidated Kinetics Corp

One-lb sound-survey meter is transistorized

7 • Miniature meter is inexpensive but highly accurate, maker claims. Fully transistorized circuitry makes it a rugged and stable performer.

Hand-held instrument samples noise in factories, offices; with its matched pickup, meter can be used to test vibration. Large scale measures sound-pressure levels from 40 to 125 db. Frequency response is said to be well within ASA tolerances in the 45- to 8000-cps spectrum.

Unit is designed for 1-hand operation with click-action knurled fingertip controls for attenuator and filter-network selectors. Power source: a mercury battery. Vest-pocket measurements: 5x3¼x1½-in.—The Korfund Company, Inc



High-capacity compressor uses less power

8 • This 400-hp stationary air compressor delivers 2280 cfm of air, works up to 125 psi. Machine is designed for heavy-duty 3-shift operation in industry, or on construction jobs and in mines. It comes packaged, needs only bolting to a steel frame preset in the concrete foundation.

The 2-stage double-acting machine has cylinders arranged in an el. Good design and balance are said to reduce specific power consumption for this model. Short stroke gives a high capacity-to-weight ratio.—Atlas Copco

English-speaking computers

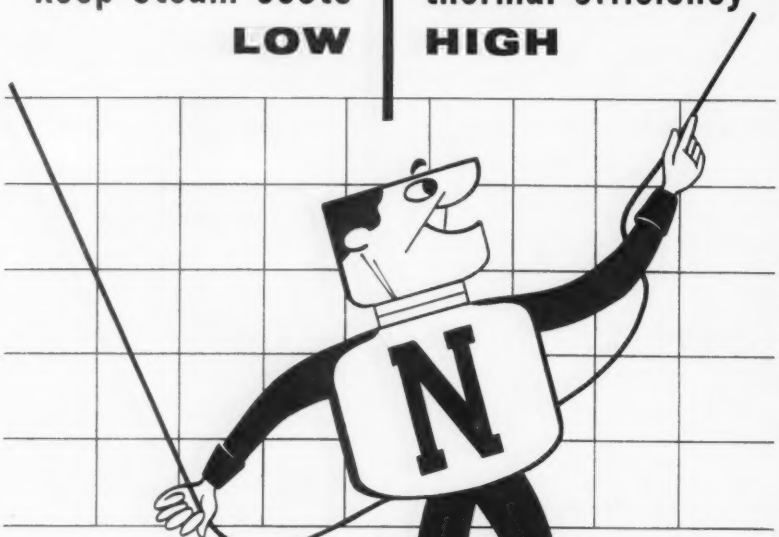
9 • GE 225 general-purpose computers will now be available equipped with the GECOM programing technique to automatically translate English-language instructions into code, and TABSOL, a systems-oriented method of describing the decision-making process in tabular form. —General Electric Company, Computer Department

continued

For more data on these developments, circle key numbers on Reader Service card, p 101

Nicholson Thermostatic Steam Traps

keep steam costs **LOW** | thermal efficiency **HIGH**



Low costs and high efficiency! Nicholson Traps give you both . . . by *design*. And here's how. Hardened stainless steel seats and valves are accurately lapped for sure, tight shut-off . . . so, there is no waste of live steam. True balanced pressure . . . the operating principle of these valves . . . assures fast intermittent discharge of condensate and air, resulting in maximum thermal value from every pound of steam produced.

As for capacity, these traps *really* have it . . . up to six times greater than ordinary traps. Maintenance? Practically none, for there is only one moving part. No links no pins. No pivots or levers. No adjustable orifices to stick or clog.

Sure, some traps cost less than Nicholson . . . but the 'savings' exist only on the invoice. In actual use, some other traps can cost you three or four times their price in annual steam waste. Be sure to weigh cost against value when *you* buy steam traps. Specify Nicholson Thermostatic Steam Traps on your lines and equipment.

W. H. NICHOLSON and COMPANY
12 Oregon St., Wilkes-Barre, Pa.
Offices in principal cities

Send for Catalog

W. H. NICHOLSON and COMPANY
12 Oregon St., Wilkes-Barre, Pa.
Please send a copy of Catalog #400
NAME_____
COMPANY_____
STREET_____
CITY_____ STATE_____

Equipment news

Begins on page 112

Ball valve is fast and easy to operate

70 • Rated at 300 lb for water, oil or gas service at 250 F, valve comes in ½- to 2-in. sizes. Just a quick quarter turn of handle opens or closes valve. You can use for vacuum service.

Ball's wiping action across seats forces out foreign matter, prevents abrasive wear which causes leakage. O-ring-stem seals assure leakproof stuffing box, according to maker—R-P&C Valve Div of American Chain & Cable Co, Inc

Just circle key numbers on the Reader Service card, page 101, to get complete product story

Ac-breakdown tester is mobile

40 • H-v-ac tester is designed for proof tests, troubleshooting and preventive-maintenance programs on electrical-distribution systems and equipment. Unit tests insulation breakdown in large motors and generators, transformers, switchgear, bushings. Models come with outputs up to 20 kv at 10 kva and 30 kv at 5 kva; larger ratings available. You can vary output continuously from zero to maximum through a 10-ft shielded cable. Measurements are

ROOF TOP

BOILER ROOM in the Brooklyn Union Gas Company Building leaves basement clear for parking 32 cars... and two

SUPERIOR PACKAGED BOILERS do the job...

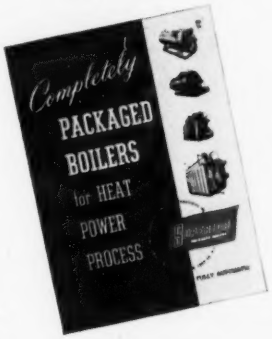
The first of two 600 hp. Superior Packaged Boilers is shown being hoisted to the top of the new 14-story Brooklyn Union Gas Co. Building in Brooklyn, New York.

These two high pressure Superior Packaged Boilers . . . probably the largest ever installed so high above the ground . . . will supply both heat and hot water for the entire 14-story structure as well as heat for a second 4-story bank building to be erected adjacent to the new sky-scraper.

The roof-top installation was planned by the consulting engineers* to make more efficient use of valuable basement space which will be used for parking 32 company cars, a car-washing rack, storage, and offices for dispatchers, drivers, and building maintenance personnel. The roof-top installation also saves both the expense and the space for a chimney extending from ground to roof-top.

Each of the Superior Packaged Boilers is equipped for fully automatic operation burning gas at high thermal efficiencies. Superior's continuous gas pilot provides maximum safety of operation.

*FRANCISCO & JACOBUS
Engineers and Architects



Superior Packaged Boilers of the fire tube type are available in 17 sizes from 20 to 600 bph. Water-tube types in sizes to 60,000 lbs./hr. The catalog illustrated provides condensed data on the world's most complete line of packaged boilers. Request catalog S-11.

Fire-Tube and Water-Tube PACKAGED BOILERS
for STEAM or HOT WATER

SUPERIOR COMBUSTION INDUSTRIES INC.
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SUPERIOR
PACKAGED BOILERS
®

For more facts circle 263 on Reader Service card, p 101

FLUIDICS* AT WORK

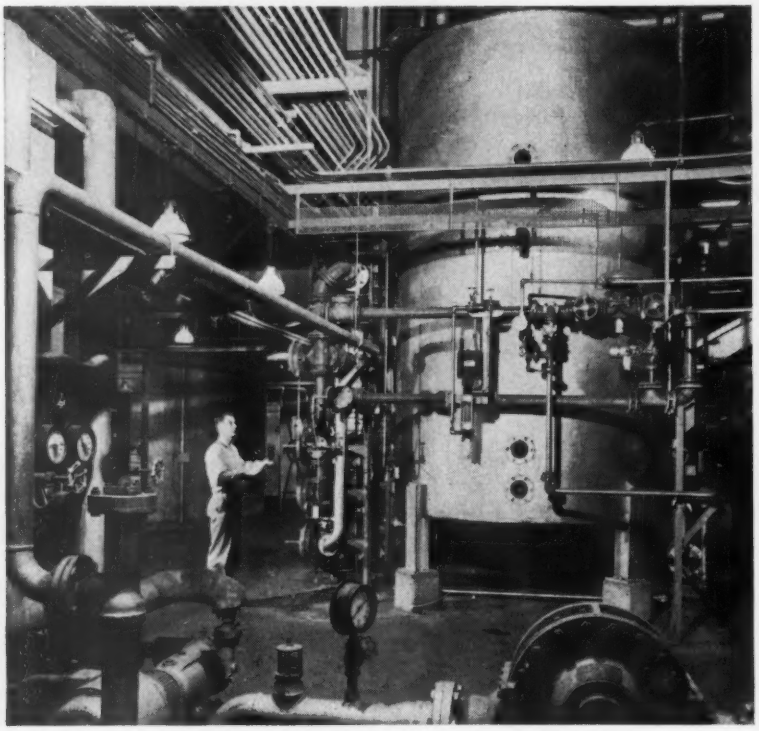


Photo courtesy Ontario Hydro.

Thirst-quencher for Ontario Hydro's largest thermal generating plant

Here almost dwarfed by its surroundings in the new R. L. Hearn Generating Station, Toronto, Ontario, this Permutit® automatic mixed-bed demineralizer helps quench the thirst of generator units 1 to 8.

This demineralizer can deliver 240,000 imperial gallons of boiler feedwater a day at a nominal flow rate of 300 gallons per minute. Total solids content of the raw water it treats is 4 grains per gallon. The unit can deliver water with an average specific conductivity of approximately 0.3 microohms per centimeter, and a soluble silica content of 0.02 ppm.

That is pure boiler feedwater.

And it saves money, too. Because this Permutit demineralizer produces its high quality water at a lower cost than possible with evaporators. Still further economies are assured by its labor-saving, push-button automatic controls.

Deaerators, too. Further feedwater treatment at Hearn Station is accomplished on units 6, 7 and 8 with three of the most advanced design open direct-contact Permutit deaerators, each guaranteed to deliver 1,450,000 lb. per hour of deaerated water. Each deaerator is designed for 100 psig pressure and provides storage capacity for 28,000 gallons of deaerated water.

The Permutit Company of Canada, Ltd. supplied the demineralizing equipment for this important job. Stone & Webster Canada, Limited were the consulting engineers. Similarly, we can work with you or your consultant to help solve boiler feedwater and other water treatment problems. Our technical staff is at your disposal.

For more information, write our Permutit Division, Dept. **PO-31,** 50 West 44th Street, New York 36, N. Y.

In Canada, The Permutit Company of Canada, Ltd., 207 Queen's Quay West, Toronto 1, Ontario.

*FLUIDICS is the Pfaudler Permutit program that integrates knowledge, equipment and experience in solving problems involving fluids.

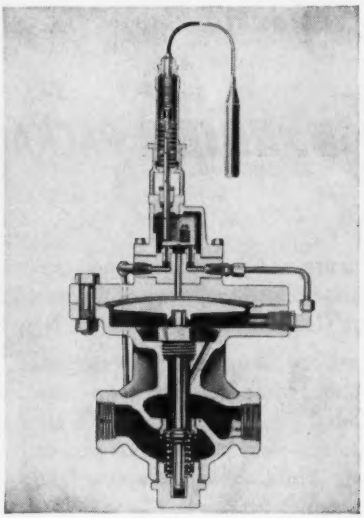
PFAUDLER PERMUTIT INC.

Specialists in FLUIDICS...the science of fluid processes

Equipment news

Begins on page 112

unaffected by regulation or load variations, maker says.—Associated Research, Inc



Temperature regulators for heating and cooling

31 • Regulators for storage heating and cooling applications are single seated, diaphragm actuated with lever type internal pilot. There are only two moving parts—no close-fitting parts to clog, bind or seize, maker says. Temperature variations are sensed by a liquid-filled thermal element, fully interchangeable with regulator on the line.—Leslie Co

Just circle key numbers on the Reader Service card, page 101, to get complete product story

Plunger type mercury relay

34 • This relay is particularly suited for heavy-duty loads—resistance heating, welding, heat-treating furnaces—says maker. There's only one moving part. No maintenance is required and nothing will wear out, maker claims. Hermetically sealed contact cannot be affected by dust, dirt, grease, moisture or oxidation. —The Mercoid Corp

continued

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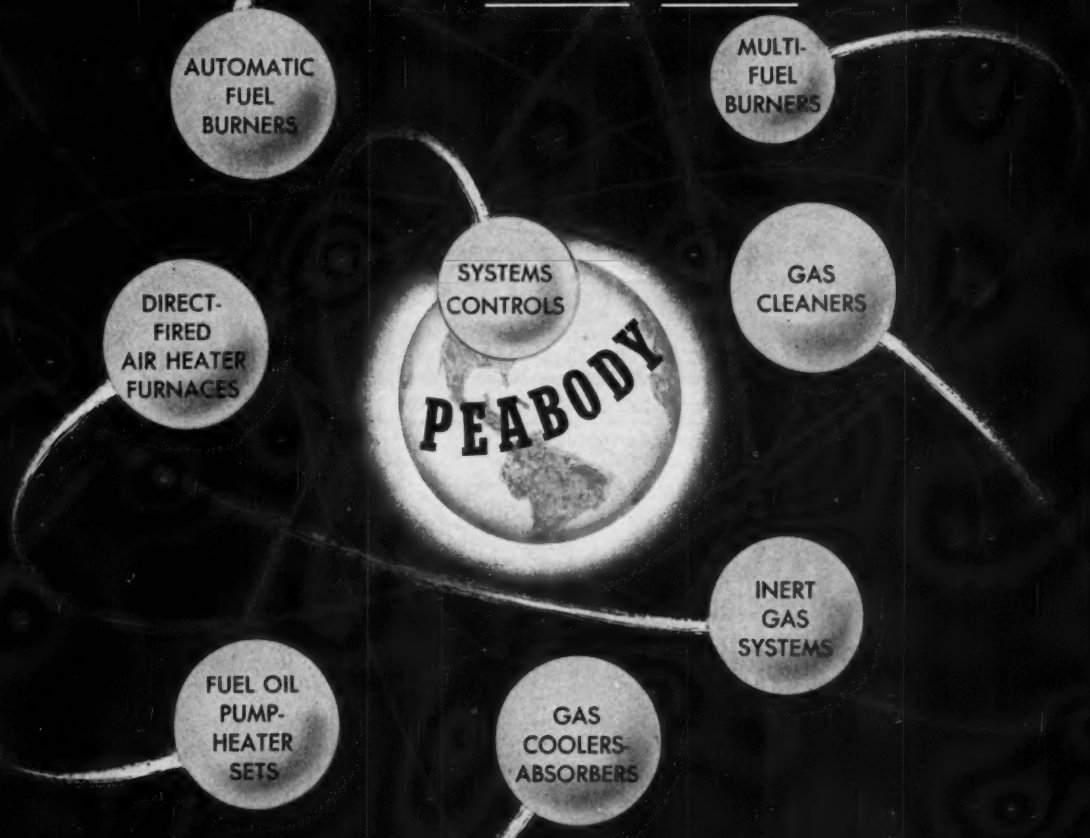
—the whole world uses!



There are many Peabody quality products in "orbit" now and others will be introduced soon. Write to us, or to our representative in your part of the world, for descriptive literature.

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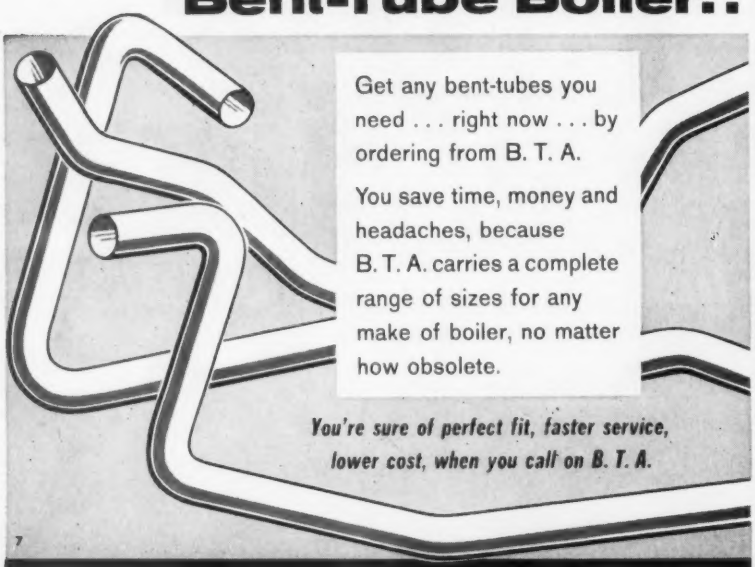

Get any bent-tubes you need . . . right now . . . by ordering from B. T. A.

You save time, money and headaches, because B. T. A. carries a complete range of sizes for any make of boiler, no matter how obsolete.

You're sure of perfect fit, faster service, lower cost, when you call on B. T. A.

BOILER TUBE COMPANY OF AMERICA

McKEES ROCKS, PA. (Pittsburgh District) Federal 1-7750

For more facts circle 266 on Reader Service card, p 101

Smoothest stack I know!

A. O. Smith glass-protected smokestacks are virtually impervious to corrosion

Smoothest stack on the market because A. O. Smith glass-protected stacks are corrosion-resistant regardless of excess condensate. This glass protection gives you three to five times longer life than with unlined steel stacks. Also pays off in lower installation and maintenance costs — lightweight A. O. Smith stacks can't rust, never require painting. Now available in *eight* attractive colors. For colorful new bulletin, write Dept. P-31.

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SMOKESTACK SALES
ATOMIC & PROCESS EQUIPMENT DIVISION
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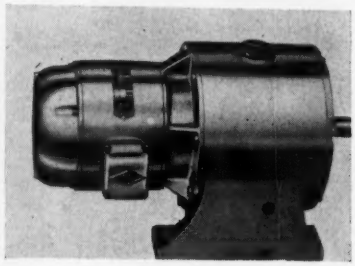
Equipment news

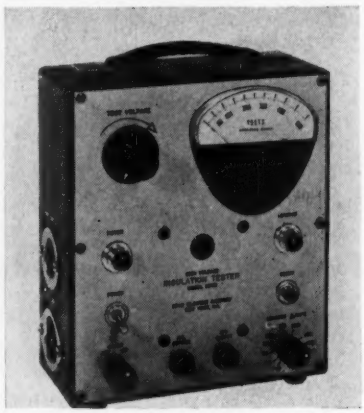
Begins on page 112



Motor and gear-reducer package

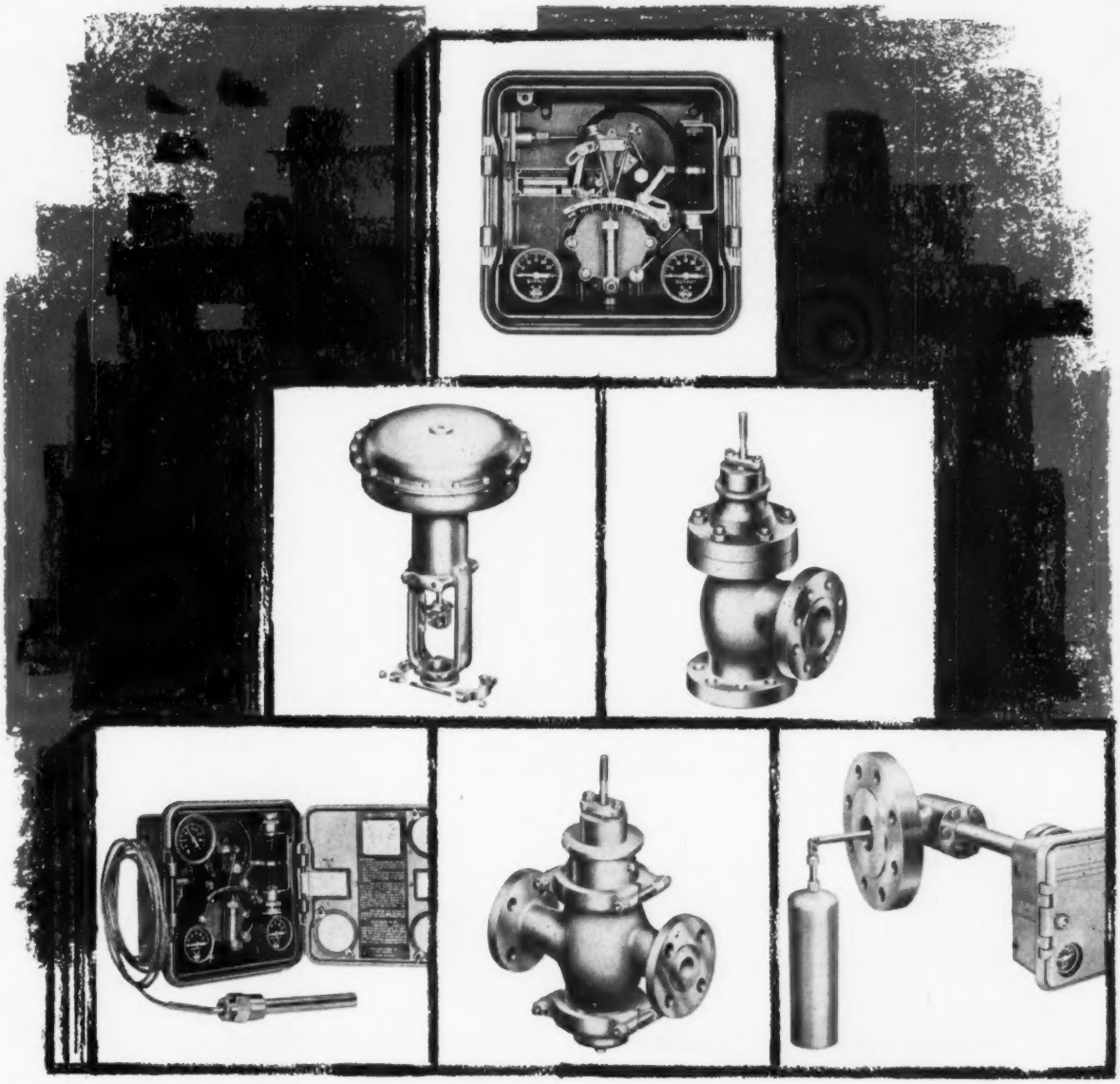
27 • Unit comes in all ratings from ½ to 50 hp. Each unit is available as a "standard" with good selection of drive motors. Use wherever machinery needs a low-speed high-torque output. Typical drive motors: fluid shaft, wound-rotor slip ring, squirrel cage, dripproof or totally enclosed.— Reuland Electric Co

Just circle key numbers on the Reader Service card, page 101, to get complete product story



Portable, nondestructive h-v insulation tester

33 • Unit has continuously adjustable output of 0- to 500-v rms, features calibrated transistorized h-v circuit breaker. Use for manual, footswitch or high-speed remote-control operation. You can reset manually or automatically after a leakage overload. Panel selector switch allows



THE RIGHT COMBINATION

The best components to build an effective fluid control system are offered by BS&B. The number of systems are countless because each process requires its own analysis to select the right combination. Seldom can a previously used combination be used in its entirety for a new application or for the improvement of an existing one. Chances are your process needs a new combination. Let BS&B give you this combination . . . the right combination to best maintain your product quality, and at the lowest possible cost. With BS&B standing behind this combination and the performance of its components, you have the assurance of *the right combination.*

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For more facts circle 268 on Reader Service card, p 101

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Sizes range from 1" to 24". Available in any desired pipe schedule. Body and disc can be carbon steel or any ASTM castable alloy. No gaskets or flanges required. Available for all types of power actuators.

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FISHER® Controls

Equipment news

Begins on page 112

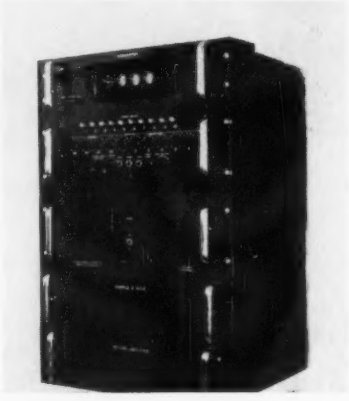
guarded or unguarded testing.—Opad Electric Company

Stationary battery charger

35 • Silicon-controlled unit replaces magnetic amplifier used as main regulator in battery chargers. Result: weight and size savings. Current limiting is provided in both "float" and "equalize" positions for overload protection to charger and battery. Units are short-circuit-proof.

There are no moving parts, relays or electronic tubes. Automatic chargers are available from 24- to 120-v dc in 1- to 125-amp capacities.—Hughes Electronics Company

Just circle key numbers on the Reader Service card, page 101, to get complete product story



Multichannel data system operates unattended

38 • System allows transmitting signals as small as 10 microvolts for distances up to 1000 miles with accuracies of 0.1%, maker says. Unit will monitor up to 250 channels of low- or high-level data on temperatures, pressures, displacements and voltages. It steps from one channel to the next at ten readings per sec, converts data into numerical form. Numerical data is then transmitted over audio radio channel or tele-

For more facts circle 270 on Reader Service card, p 101

circle 271 on Reader Service card, p 101 ➤

ANKOTALLIC SPIRAL WOUND GASKETS

Withstand even the most severe service conditions for an entire range of pressures.

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SPOKANE, WASH.
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WILMINGTON, CAL.

Ankotallic Spiral Wound Gaskets are made of one continuous strip of preformed metal. They are wound spirally from the inside to the outside with a cushion of filler between each metal ply. In this way it is possible to increase or decrease the number of metal and filler plies, and enable the gasket to survive under severe service conditions and a range of pressures.

It is the preformed U-shaped groove in the metal that provides the safe interlocking feature and creates a type of artificial "lung" that reacts to the existing conditions, be they mechanical compression, temperature changes, or internal pressure variations.

Ankotallic was designed on a principle that has been tried and proved. In no other type of gasket is it possible to vary the compressibility to meet requirements of a pre-designed joint with bolt loading limits already established.

In addition to being able to increase or decrease the number of plies in a given flange area, compressibility of Ankotallic Gaskets is further regulated by taking into consideration the hardness and resiliency of the type of metal specified for the particular service condition.

Various styles of Ankotallic Spiral Wound Gaskets are carried in stock for use on boiler manholes, tube caps, waterwalls, economizers and many other boiler accessories.

THE ANCHOR PACKING COMPANY

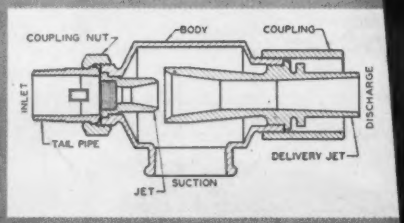
GENERAL OFFICES: PHILADELPHIA, PA.
FACTORIES: MANHEIM, PA. ELKHART, IND. MONTREAL, CAN.

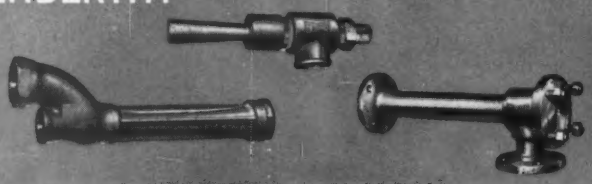
FIBROUS AND METALLIC PACKINGS FOR EVERY INDUSTRIAL PURPOSE

SIMPLICITY

For trouble-free operation

JET PUMPS by PENBERTHY





If you have a liquid heating, circulating, aerating, agitating, pumping or blending application (to mention a few), you'll find, chances are, that there just isn't a more economical, efficient, trouble-free device for handling the job than a Penberthy Jet Pump. They cost little to buy, little to install. And maintenance? Practically non-existent, for there are no moving parts, no packing glands, nothing to lubricate.

Penberthy, what's more, as the #1 name in Jet Pumps . . . with almost 70 years' experience in the field . . . offers you the broadest available selection of models, standard or special, steam, air or liquid operated, in a variety of materials. Ask a Penberthy engineer for assistance with your jet pump application.

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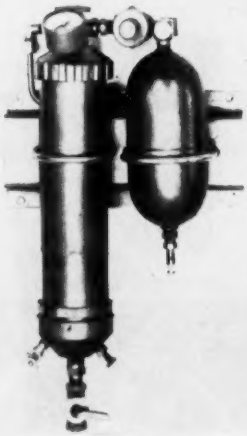
phone. At the same time data is being printed, taped or perforated.—Communications Control Corp



Pneumatic lubricator for troublesome problems

71 • Lubricator is basically air-powered grease or oil cup with dual metering adjustments. Air regulator controls incoming air, small needle valve at lubricant outlet controls flow to bearings, etc. You can operate in remote locations where plant air is not available since air tank is automatically recharged with each lubricant loading.

Unit will handle anything from light spindle oils to heavy grease. Air-power principle ends erratic and undependable flow problems common to spring-loaded types, maker says.—Pan-Tech Engineering Company

Just circle key numbers on the Reader Service card, page 101, to get complete product story

Electric operators for metalclad switchgear

28 • Operators are for h-v metalclad fused-load-interrupter switchgear for 4.8- to 14.4-kv switching centers, substation primaries, secondaries and service entrances. Operator uses a motor-operated worm-driven gearhead powered by control circuits of

This compact Package Air Preheater is being installed on a 150,000 lb/hr boiler at Olin Mathieson Chemical Corp.'s Brandenburg, Kentucky, petrochemical plant. When in operation it will recover enough heat from the boiler exhaust to increase efficiency of the boiler between 8% and 9%.

OLIN MATHIESON RECOVERS 360°F FROM BOILER EXHAUST WITH 11½′ x 11′ x 8′ PREASSEMBLED LJUNGSTROM® PACKAGE AIR PREHEATER

Olin Mathieson specified a Ljungstrom Package Air Preheater because it saves space as well as fuel. Mathieson's Ljungstrom occupies only about 1000 cubic feet, but cuts boiler exhaust temperature from 680°F to 320°F — puts 360° of heat back to work in the boiler.

The compact preassembled Package Air Preheater is ready to run when it's delivered—just connect to the power line and ducts, and it's on-stream. You make big savings on installation because there's no on-the-spot erection.

You can use a Ljungstrom Package Air Preheater on boilers from 25,000 to 250,000 pounds of steam per hour. For more information, write today for your free copy of a 14-page booklet.

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

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(See Thomas' Register and Conover-Mast Purchasing Dir.)

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THE BELMONT PACKING & RUBBER COMPANY • PHILADELPHIA 37, PA.

For more facts circle 274 on Reader Service card, p 101

12-, 48-, 125- or 250-v dc or 12- or 240-v ac. It can be manually operated. Interlock switch prevents motor from operating when hand crank is engaged.—S&C Electric Company

Hand embossing tool identifies pipes

26 • Lightweight aluminum tool for labeling and identifying electrical circuits, pipes, meters, panels and controls is quick and economical. You just dial letters and press handle to emboss. Built-in cutoff blade trims finished label to exact size. Embossing dies give sharp raised letters.—Dymo Industries, Inc

Just circle key numbers on the Reader Service card, page 101, to get complete product story

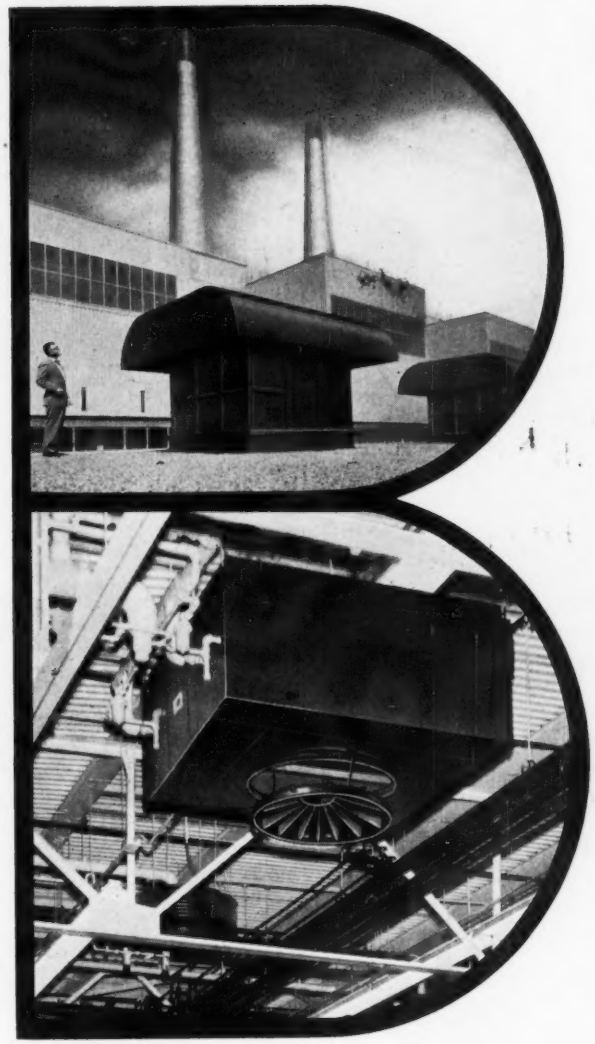
Control cable has polyethylene insulation

29 • Cable with chemically cross-linked polyethylene insulation is for general use in air, conduit, underground ducts or for direct burial. Thermosetting insulation combines electrical with thermal properties.

Cable can be spliced and terminated in same way as any other thermosetting type. Available in 600- or 1000-v rating with two through 12 conductors.—General Electric Company

BUFFALO PACKAGE UNITS

VENTILATE LARGE AREAS AT LOW COST



1 EXHAUSTING THRU THE ROOF—the best way to remove fumes, dust, vapors and stale air from large working areas where ducts are not feasible. Buffalo Power Roof Ventilators like this Style "H" Sky-Vent are easily-installed, weatherproof "packages" that do the job to perfection. Just mount in roof opening over areas to be ventilated — your own maintenance staff can do it! Gain further savings thru Buffalo efficiency and freedom from troubles. 12″ to 120″ wheel sizes (1000 to 250,000 cfm) for any ventilation job you may have. Write for Bulletin FM-2345 for all details.

2 REPLACING EXHAUSTED AIR WITH FRESH, CLEAN AIR. Buffalo Makeup Air Units like this ceiling installation draw in fresh outside air, heat it, filter it and distribute it properly — replacing air and heat removed by exhaust systems or forced draft fans. Buffalo builds a complete line of Makeup Air Units, including Heating and Ventilating Units and "PC" Cabinets for simplified installation thru roofs or outside walls. Capacities and designs to suit your needs, quality construction to give you trouble-free satisfaction at lowest operating costs.

Buffalo makes Fans and Central System Air Conditioning Units to match the many variations in ventilating requirements from plant to plant. For suggestions on your specific problem, consult your nearby Buffalo representative.

"Buffalo"

AIR HANDLING DIVISION

BUFFALO FORGE COMPANY

Buffalo, New York

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

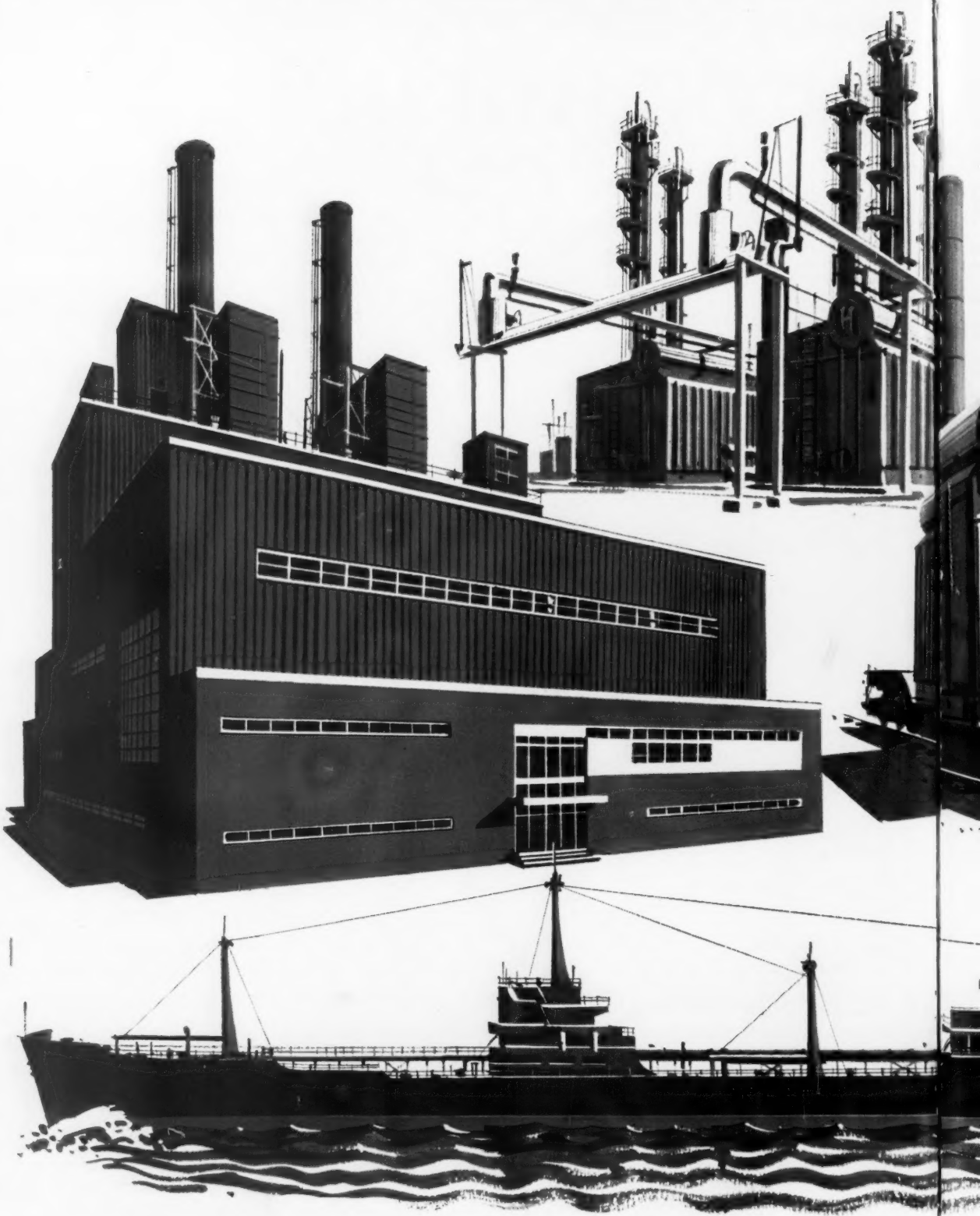
'Buffalo' Air Handling Equipment to move, heat, cool, dehumidify and clean air and other gases.

'Buffalo' Machine Tools to drill, punch, shear, bend, slit, notch and cope for production or plant maintenance.

'Buffalo' Centrifugal Pumps to handle most liquids and slurries under a variety of conditions.

Squier Machinery to process sugar cane, coffee and rice. Special processing machinery for chemicals.

For more facts circle 275 on Reader Service card, p 101



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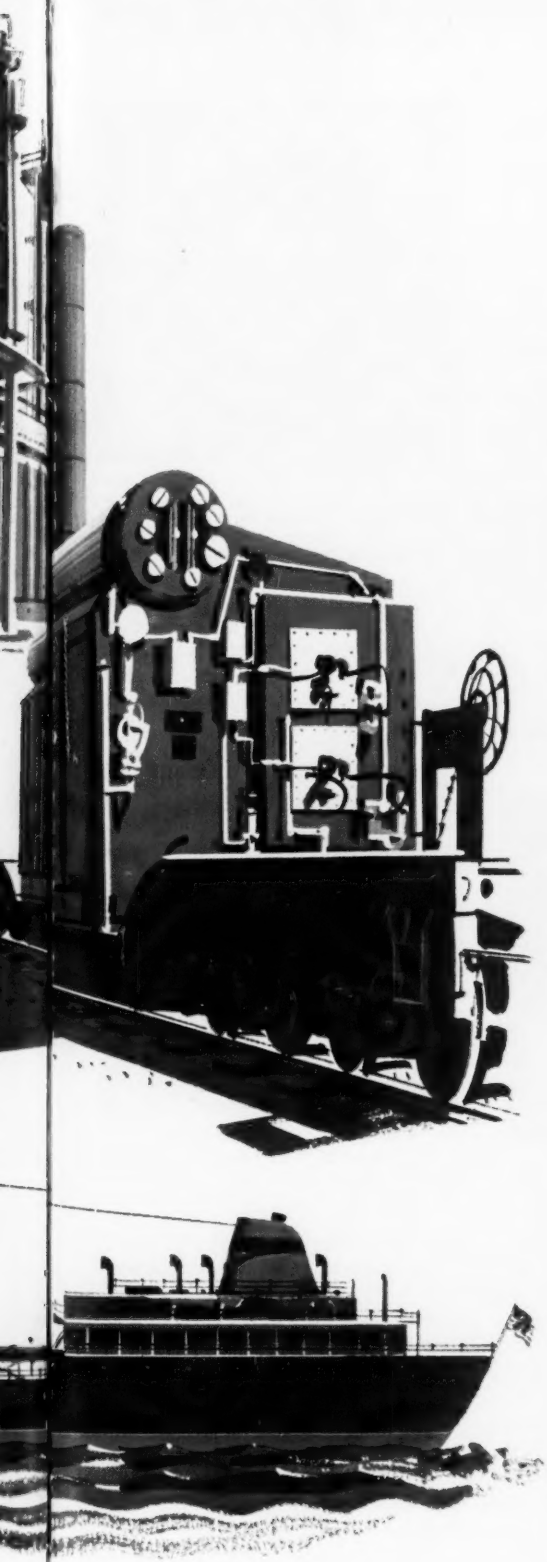
Central Station and Industrial Steam Generators • Steam Condensers and Pumps • Cooling Towers

Pulverized Fuel Systems • Feedwater Heaters • Packaged Steam Generators • Nuclear Components



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Through contributions in every field where steam power is used, Foster Wheeler has accumulated knowledge and experience that are yours today in all Foster Wheeler equipment and services.

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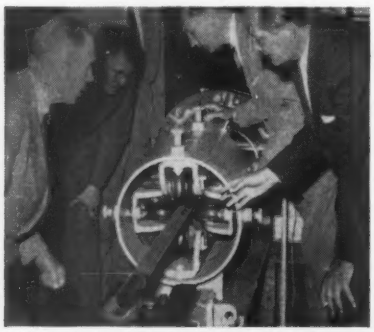
For more facts circle 276 on Reader Service card, p 101

ANACONDA CONDENSER AND HEAT EXCHANGER CLINIC

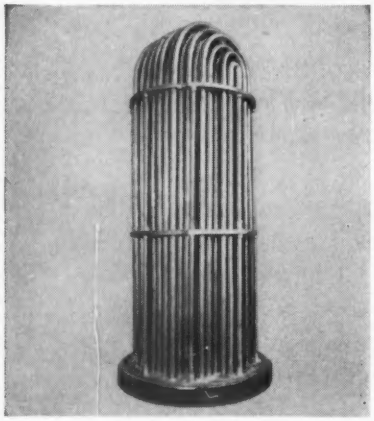
"Cupralum," lead-surfaced Anaconda copper tube, offers practical answers to some tough corrosion problems

If you'd be interested in more compact, more economical heat transfer units for handling corrosive liquors — sulfuric, chromic, phosphoric acids, sulfites, sulfates, alum, and the like — you should know about Cupralum*. Cupralum, a product of Knapp Mills, Inc., is Anaconda copper or copper-alloy tube to which a uniform, dense-structured, extruded chemical lead surfacing has been metallurgically bonded.



Alfred P. Knapp, chairman, Knapp Mills, Inc., explains to visitors how his company's patented drawing process metallurgically bonds lead surfacing to copper tube.

THE OUTSIDE lead surface, which may be from ⅛" to ½" thick, resists concentrations of acids—of sulfuric acid, for example, up to about 85% and up to 428 F. Being bonded to the copper, it expands and contracts with the copper during temperature cycling. Without the metallurgical bond, the lead would creep and eventually fail—an inherent weakness of all-lead tubing.

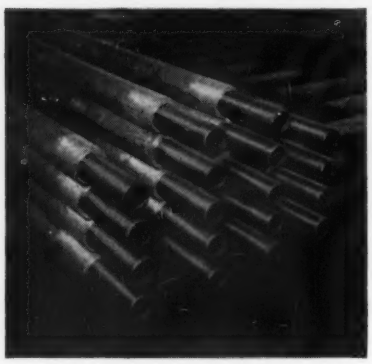


Two U-bend Cupralum tube bundles like this are used in a Ferrolum (lead-surfaced steel) separator tower to boil off ammonia from a urea carbonate ammonia solution—in the production of urea fertilizer. Anaconda copper tube core 1" O.D., 12 gauge, handles 150-lb. steam. Lead surface is 3/16 inch thick. Separator tower operates at 145 C (293 F) and 240 psi.

THE COPPER or copper-alloy tube inside provides strength to make Cupralum self-supporting — and to stand steam pressures up to 150 psi in standard wall thicknesses offered. It also provides its high corrosion resistance internally to cooling waters, steam, and refrigerants.

Most important, copper offers its high heat transfer rate. Because of the metallurgical bond with the lead, the over-all heat transfer rate of Cupralum is high—higher than all-lead tube and higher than that of iron and steel.

THE NET RESULT is that a given heat transfer job can be done with fewer square feet of surface — for a more compact unit. Or it is possible to get increased capacity in present existing space.

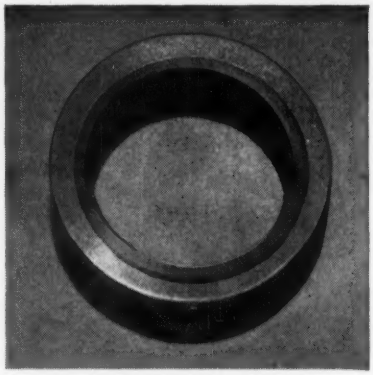


Lead surfacing removed from ends of Cupralum tubes preparatory to insertion in lead-clad steel tube sheet. Tube ends are usually rolled, but for severe thermal cycling service, may be brazed to outer steel face of tube sheet.

In many cases, the first cost of the coil is lower. Usually this is true where higher steam pressures than those previously used are available—or where expensive, hard-to-fabricate alloys have been used. Improvement of the heating or cooling cycle is another source of savings. Under any circumstances, a long operating life and easy maintenance provide over-all economy.

NUCLEONIC APPLICATIONS. Cupralum with a thicker surfacing of lead is being used increasingly in the nuclear industry. For gamma shields that must be cooled, Cupralum coils are built in to provide efficient heat transfer from the shield to the cooling medium.

Where radioactive liquors and spent resin discharge from demineralizers must be conveyed through process piping into process vessels for concentrating the radioactive solution, Cupralum piping prevents the escape of gamma radiation. In nuclear applications, the lead surfacing may be 1" to 8" thick.



Cutaway section of Cupralum tube. It is produced in 20' lengths or in long continuous coils —from 40' to 100' depending on diameter. It is easy to bend and fabricate. Reliable jointing techniques have been developed.

Lead surfaces of Cupralum tubes and of tube sheet are fused by lead-to-lead welding. Then an extra thickness of lead is applied at the joint for extra protection.

FOR MORE INFORMATION. For detailed data on Cupralum, write Knapp Mills, Inc., Wilmington, Del. Or see your Anaconda representative, who can also provide data on the full line of Anaconda copper and copper-alloy tubes—arrange for technical assistance in meeting special corrosion and heat transfer problems. Anaconda American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 6071L

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ANACONDA®

TUBES AND PLATES FOR CONDENSERS AND HEAT EXCHANGERS

Anaconda American Brass Company

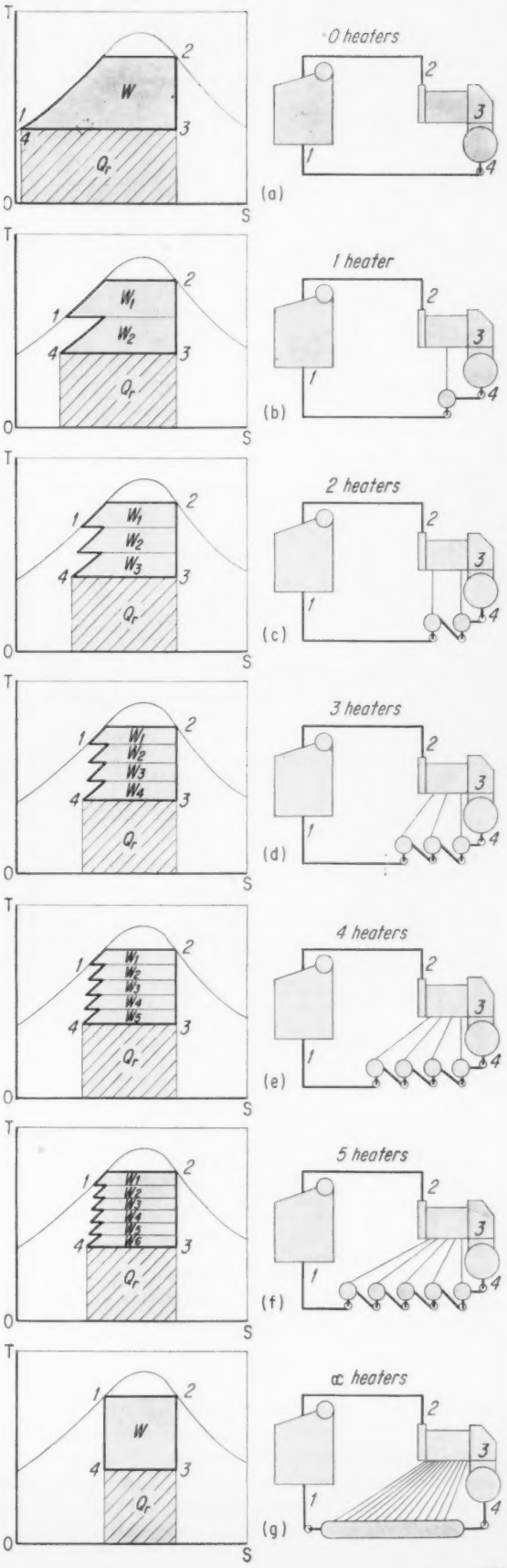
By B G A SKROTZKI
Associate Editor

The versatile regenerative cycle can be arranged in many ways at the designer's will. Here we learn how . . .

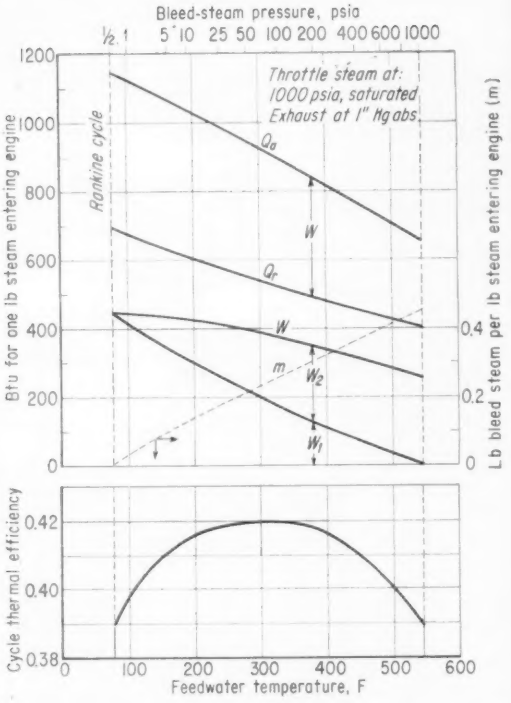
Heaters raise cycle thermal efficiency

Evolution of the steady-flow steam cycle from the simple Rankine to the infinite-heater bleed regenerative is shown in Fig. 1. Cycle diagrams show the growing complication of the plant as heaters and pumps are added. Proportionate-area T-S charts show that the net work areas shrink with added heaters. But the heat-rejected areas Q_r shrink at a faster rate, so net effect raises the thermal efficiency. As we learned in the last part, for an infinite number of heaters we get the Carnot-cycle diagram of Fig. 1*g*.

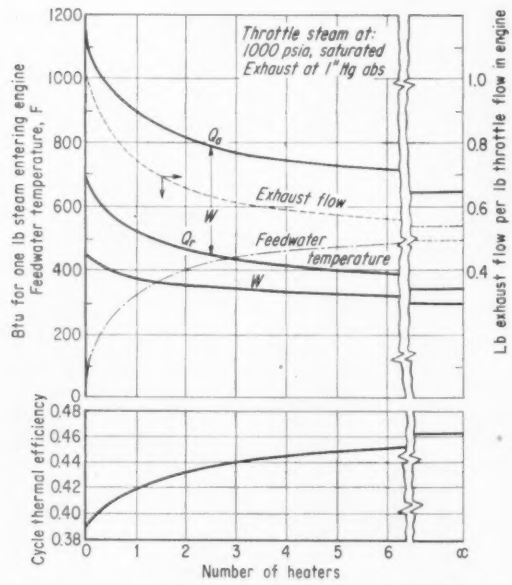
Heater placement. In Fig. 1*b*, the 1-heater cycle, we can bleed the engine anywhere along its length from the inlet or throttle down to the exhaust for feedwater heating. If we tap steam from the exhaust, we actually would take no bleed steam because the saturation temperature of the exhaust steam and the condensed liquid are the same and there would be no heat transfer between them. But as we move the bleed-steam



1 Adding heaters at proper places raises thermal efficiency of regenerative cycle. Each additional heater adds smaller increment of efficiency, but theoretically an infinite number of heaters will raise cycle to work at the ultimate Carnot efficiency


Bleed-steam pressure, psia
½ 1 5 10 25 50 100 200 400 600 1000
Throttle steam at: 1000 psia, saturated
Exhaust at 1" Hg abs
Rankine cycle
Btu for one lb steam entering engine
Lb bleed steam per lb steam entering engine (m)
Cycle thermal efficiency
Feedwater temperature, F

2 Performance of 1-heater bleed cycle depends on pressure of bleed steam taken from the engine for heating


Throttle steam at: 1000 psia, saturated
Exhaust at 1" Hg abs
Exhaust flow
Feedwater temperature
Btu for one lb steam entering engine
Feedwater temperature, F
Lb exhaust flow per lb throttle flow in engine
Cycle thermal efficiency
Number of heaters

3 Adding heaters to bleed cycle improves overall thermal efficiency at diminishing increments of gain

tap toward the engine inlet we would get higher-pressure and -temperature steam and deliver higher-temperature feedwater to the steam generator. Fig. 2 shows how the cycle factors change with the feedwater temperature and bleed-steam pressure as we do this. As feedwater temperature is raised, Q_a drops. It reaches a minimum when we bleed live steam from the engine throttle—this steam has not passed through the engine at all.

Diminishing Q_a means Q_r also drops, but not at as fast a rate. This results in W shrinking as feedwater temperature rises. But W has two components, W_1 generated by the steam flowing between throttle and

Calculating an actual

Given: Throttle steam at 2000 psia and 1000 F; steam-generator efficiency = 0.88; station auxiliary consumption (excluding pump work) = 6% of W_e; engine efficiency of engine sections each = 0.8; engine cycle with three feedwater heaters and bleed-steam pressures as Fig. 4 shows; 1-in.-Hg-abs exhaust pressure to condenser.

Solution: From steam tables find $H_2 = 1474.5$ Btu per lb and $S_2 = 1.5603$ Btu per lb, F.

First find actual enthalpy H_3' of steam at 750-psia bleed pressure in engine. As in Fig. 6, on Mollier chart find H_2 and read at constant-S expansion to 750 psia, $H_3 = 1346.7$ Btu per lb. Since:

$$e_e = \frac{H_2 - H_3'}{H_2 - H_3} = 0.8 = \frac{1474.5 - H_3'}{1474.5 - 1346.7} \quad (1)$$

$H_3' = 1474.5 - 0.8(1474.5 - 1346.7) = 1372.2$ Btu

From Mollier chart find $S_3' = 1.5819$ Btu per lb, F at 750 psia and 1372.2 Btu per lb.

At constant-S expansion from H_3' find $H_4 = 1230.0$ Btu per lb at 200 psia. From equation similar to (1) find:

$$H_4' = H_3' - e_e(H_3' - H_4) \quad (2)$$
$$= 1372.2 - 0.8(1372.2 - 1230.0) = 1258.4 \text{ Btu}$$

From Mollier chart find $S_4' = 1.613$ Btu per lb, F.

At constant-S expansion from H_4' find $H_5 = 1059.5$ Btu per lb at 16 psia. Next find:

$$H_5' = H_4' - e_e(H_4' - H_5) \quad (3)$$
$$= 1258.4 - 0.8(1258.4 - 1059.5)$$
$$= 1099.2 \text{ Btu per lb}$$

From Mollier chart find $S_5' = 1.6712$ Btu per lb, F.

At constant-S expansion from H_5' find $H_6 = 898.2$ Btu per lb at 1-in.-Hg-abs exhaust pressure.

$$H_6' = H_5' - e_e(H_5' - H_6) \quad (4)$$
$$= 1099.2 - 0.8(1099.2 - 898.2) = 938.4 \text{ Btu per lb}$$

Mollier chart shows moisture at exhaust = 15.1%

Overall engine efficiency is better than engine-section efficiency because of partial available-energy recovery between sections. Constant-S expansion from throttle to 1-in.-Hg-abs exhaust gives $H_{3s} = 838.3$ Btu per lb, assuming all the steam went to the condenser. Then:

$$\text{Overall } e_e = \frac{H_2 - H_6'}{H_2 - H_{3s}} \quad (5)$$
$$= \frac{1474.5 - 938.4}{1474.5 - 838.3} = 0.8425 \text{ compared to } 0.8$$

for individual engine sections.

For each heater, energy in = energy out; also note that heated condensate leaving each heater is a saturated liquid at the heater bleed-steam pressure. Zero pressure drop is assumed between engine bleed point and heater inlet. Pump work comes from chart with Compressed Liquid Table in Keenan & Keyes Steam Tables.

No. 1 heater balance

$$H_3'm_1 + H_{12}(1 - m_1) = H_{13}$$

regenerative-cycle performance

$H_3'm_1 + (H_{11} + W_{p2})\ (1 - m_1) = H_{13}$
$1372.2m_1 + (355.4 + 1.7)\ (1 - m_1) = 500.8$
$m_1 = 0.1416$ lb per lb throttle flow
$H_1 = H_{13} + W_{p1} = 500.8 + 4.7 = 505.5$ Btu per lb

No. 2 heater balance
$H_4'm_2 + H_{10}\ (1 - m_1 - m_2) = H_{11}\ (1 - m_1)$
$H_4'm_2 + (H_9 + W_{p3})\ (1 - m_1 - m_2) = H_{11}\ (1 - m_1)$
$1258.4m_2 + (184.4 + 0.5)\ (0.8584 - m_2)$
$= 355.4 \times 0.8584$
$m_2 = 0.1365$ lb per lb throttle flow

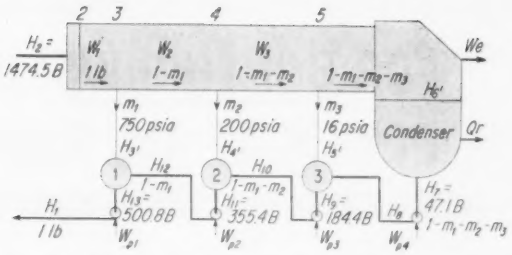
No. 3 heater balance
$H_5'm_3 + H_8\ (1 - m_1 - m_2 - m_3) = H_9\ (1 - m_1 - m_2)$
$H_5'm_3 + (H_7 + W_{p4})\ (1 - m_1 - m_2 - m_3)$
$= H_9\ (1 - m_1 - m_2)$
$1099.2m_3 + (47.1 + 0.1)\ (0.7219 - m_3)$
$= 184.4 \times 0.7219$
$m_3 = 0.0942$ lb per lb throttle flow

Engine-section W_e per lb throttle flow
$W_1 = H_2 - H_3' = 1474.5 - 1372.2 = 102.3$ Btu
$W_2 = (H_3' - H_4')\ (1 - m_1)$
$= (1372.2 - 1258.4)\ (1 - 0.1416) = 97.7$ Btu
$W_3 = (H_4' - H_5')\ (1 - m_1 - m_2)$
$= (1258.4 - 1099.2)\ (1 - 0.1416 - 0.1365)$
$= 115.0$ Btu
$W_4 = (H_5' - H_6')\ (1 - m_1 - m_2 - m_3)$
$= (1099.2 - 938.4)\ (1 - 0.1416 - 0.1365 - 0.0942)$
$= 100.9$ Btu
Total $W_e = 102.3 + 97.7 + 115.0 + 100.9 = 415.9$ Btu
Total $W_p = 4.7 + 1.7 + 0.5 + 0.1 = 7.0$ Btu
Station auxiliaries $= 415.9 \times 0.06 = 25.0$ Btu
Net station $W = 415.9 - 7.0 - 25.0 = 383.9$ Btu

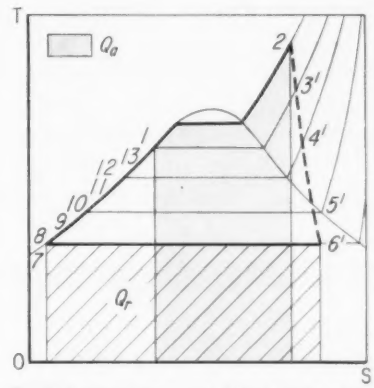
Check:
$Q_a = H_2 - H_1 = 1474.5 - 505.5 = 969.0$ Btu
$Q_r = (H_6' - H_7)\ (1 - m_1 - m_2 - m_3)$
$= (938.4 - 47.1)\ 0.6277 = 559.5$ Btu
$W_e - W_p = Q_a - Q_r = 969.0 - 559.5 = 409.5$ Btu

This compares with 415.9 – 7.0 = 408.9 Btu from the work calculations. This is a good check; difference of 0.6 Btu comes from errors in Mollier-chart and slide-rule readings. We'll use 408.9 Btu as correct.

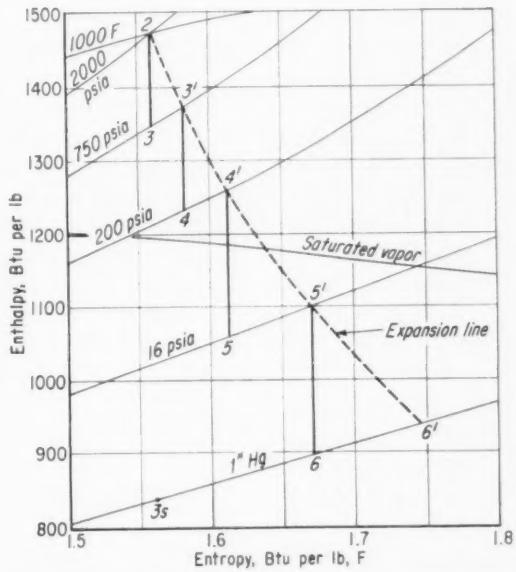
Plant-energy input $= Q_a/e_b = 969.0/0.88 = 1101.0$ Btu
Plant thermal efficiency $= W/(Q_a/e_b)$
$= 383.9/1101.0 = 0.3486$
Engine thermal efficiency $= W_e/Q_a$
$= 415.9/969.0 = 0.4292$
Plant heat rate $= 3413/0.3486 = 9790$ Btu per kwhr
Engine heat rate $= 3413/0.4292 = 7950$ Btu per kwhr
Engine steam rate (throttle) = engine HR$/(H_2 - H_1)$
$= 7950/(1474.5 - 505.5) = 8.21$ lb per kwhr



4 This 3-heater bleed cycle with given steam pressures and saturated feedwater states is used in example at left



5 T-S chart for actual bleed cycle gives true-state points for steam and water



6 Mollier chart shows expansion line of steam flowing through engine at 80% engine efficiency in sections

bleed point and W_2 generated by steam flowing between bleed point and exhaust. W_1 is the total output at minimum feedwater temperature but drops to zero when we bleed live steam from the engine inlet. W_2 grows as W_1 shrinks to zero output.

Bleed-steam flow m steadily rises as we raise the feedwater temperature by tapping higher-pressure bleed steam. Most important factor is effect on thermal efficiency. We get the same thermal efficiency either at Rankine-cycle conditions or by heating feedwater by bleeding live steam. At just half the total potential feedwater-temperature rise we get a maximum gain in thermal efficiency. For

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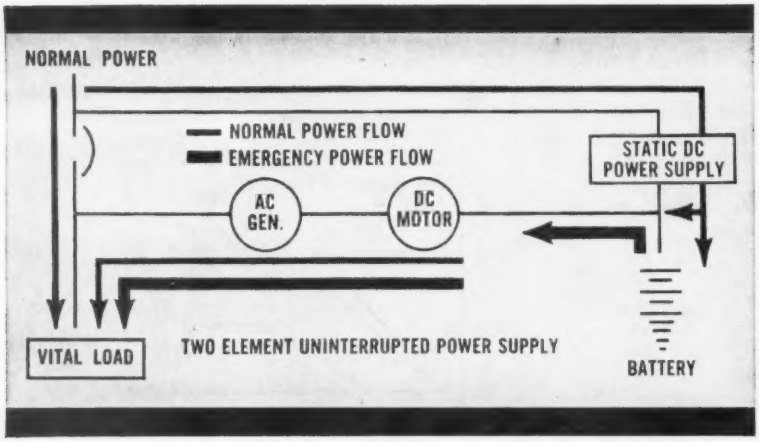

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Begins on page 129

the conditions shown this amounts to three percentage points, a rise from 39 to 42% in round figures.

Multiple heating. The 1-heater study shows the importance of properly placing the tap for bleed steam. Now let's study the effect of adding more heaters for feedwater heating, Fig. 3. We can use a rule of thumb in placing n heaters in series by tapping the bleed steam so temperature rise per heater is $1/(1 + n)$ of the temperature difference between boiler saturated temperature and condensate temperature. This gives about the best thermal efficiency for each number of heaters.

Fig. 3 shows that as we add heaters to the Rankine cycle, Q_a drops, but with a sharply diminishing rate; Q_r follows the same general trend. W shrinks sharply with the first two heaters but then drops slightly for more heaters. Exhaust flow of the engine, another way of measuring the total bleed steam, parallels Q_a closely. Feedwater temperature rises sharply at first and then reaches a maximum at infinite number of heaters. With these changes we steadily gain in cycle thermal efficiency, but after ten heaters the gain becomes quite small per added heater. The variation of Q_a, Q_r and W can be seen in the T-S charts of Fig. 1.

Practical cycle. In the table and Fig. 4 to 6 we look at a simplified irreversible, regenerative bleed cycle. We have given steam conditions at throttle and exhaust of the engine and specified engine efficiencies of individual sections of the engine, and the pressures at which steam is bled from the engine.

With this data we first find the state of the steam at each engine bleed point. For a definition of "engine efficiency" see Part 44, Dec 1960, p 171. After establishing the engine expansion line on a Mollier chart, we figure the amounts of steam bled to each heater. This calculation starts by recognizing that one lb of water enters the boiler for heating and this same lb of fluid enters the engine as steam. Where bled steam is superheated we assume feedwater

For more facts circle 278 on Reader Service card, p 101

IT'S NOT TOO EARLY TO THINK OF NEXT WINTER'S COAL HANDLING PROBLEMS

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- **Overloaded conveyors**
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Get ready *now*—for the worst conditions next winter can bring. Investigate Pennsylvania Frozen Coal Crackers.

These are the crushers especially designed and widely used for handling frozen coal at track delivery points and storage yards.

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Wide feed openings permit use of *open-throated hoppers.* Frozen masses of coal are dumped (with rotary car dumpers) directly into hoppers. No need for grates. Frozen coal works its way freely to the hopper bottom where the crackers' special teeth break it up.

Result—uniform product with limited top-size and minimum fines is fed conveyors, providing protection from overloads . . . insuring continuous flow of coal.

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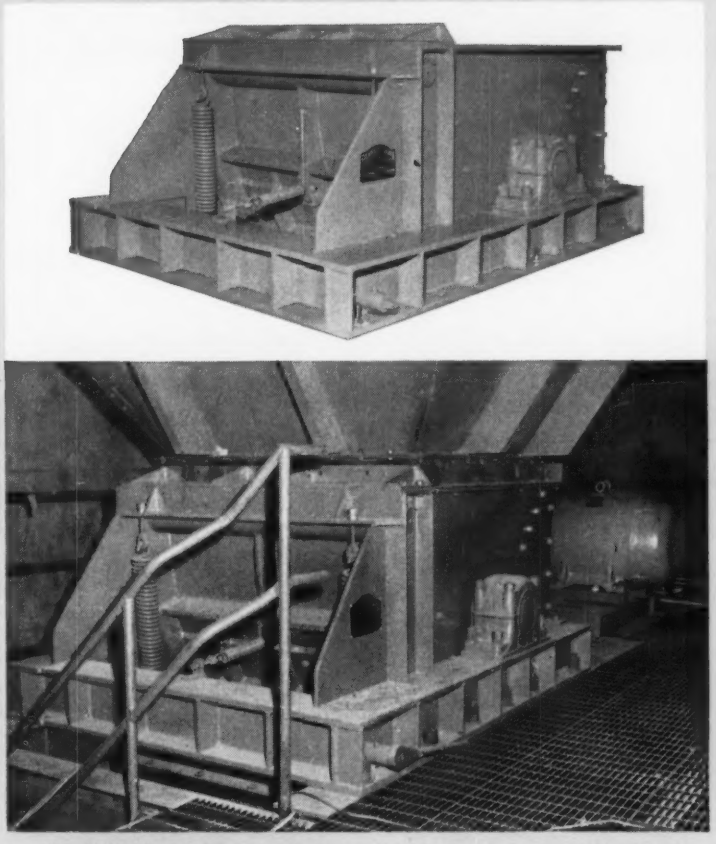

30 x 60 Single Roll Pennsylvania Frozen Coal Cracker in service at Merrimack Steam Station, Public Service Company of New Hampshire, Concord, N.H.

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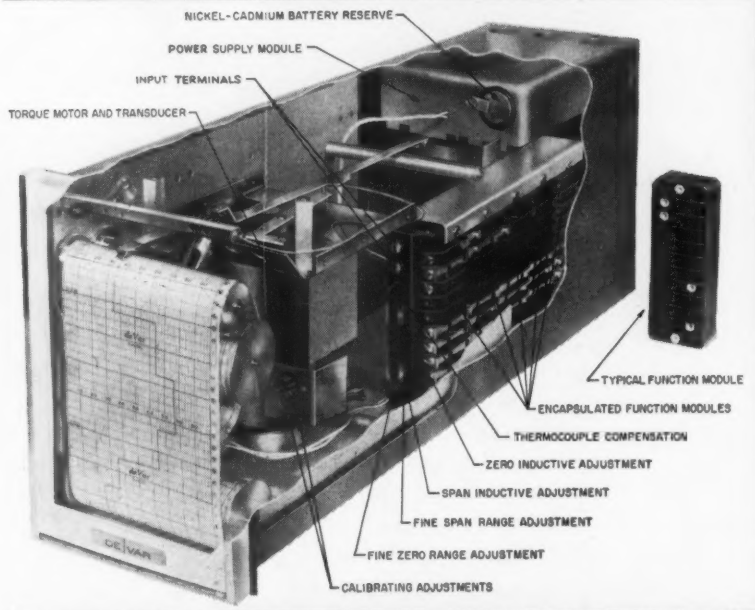

- Potentiometer Recorder handles any mv. DC input from 0-5 mv.
- Receiver Recorder handles signals from 1V. or 100μa
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The high performance characteristics of this recorder are unmatched by any other miniature recorder. In fact, some of the novel design features (e.g. DC input isolation and noise-free DC output signals) offer advantages found only in the most expensive full-size self-balancing potentiometric recorders. The DE VAR Recorder represents the ultimate in convenience, reliability, and flexibility in operation.

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Thermo refresher

Begins on page 129

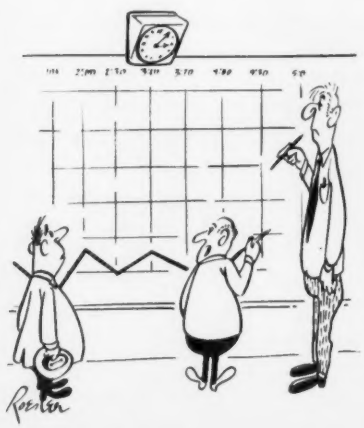
temperature equals saturation temperature corresponding to bleed pressure of the extracted steam.

We know all factors about heater 1 except amount of steam bled from the engine m_1 and amount of feedwater entering it from heater 2. But the feedwater entering must be $(1 - m_1)$ lb so we have just one unknown. Applying the First Law we can set up an energy balance for the heater and solve for m_1.

After finding m_1 we can figure the balance about heater 2 to get m_2 and then do this for heater 3 to find m_3. Amount of steam extracted tells us the amount of steam flowing through each section of the engine; then we can calculate amount of W produced in each section. With this data established we can figure heat input and rejection, engine and plant thermal efficiency and heat rates and an engine steam rate.

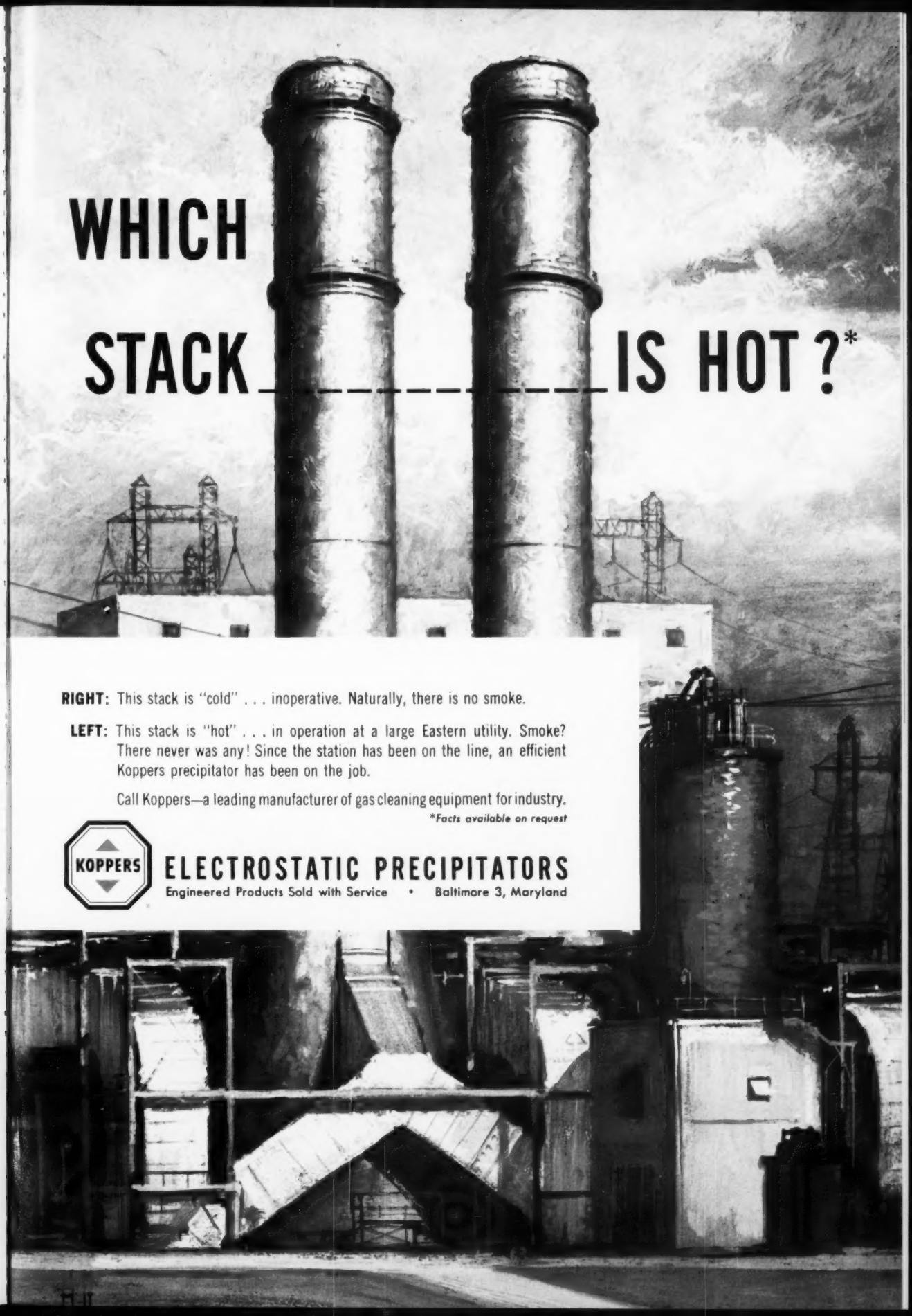
Next month we study combined reheat-regenerative cycles and binary-vapor cycles.

Benmore Station, New Zealand's largest hydroelectric power station and second largest in the Southern Hemisphere, will be delivering power by 1965.



"He stands by for power peaks."

For more facts circle 280 on Reader Service card, p 101
circle 281 on Reader Service card, p 101 ➤



RIGHT: This stack is "cold" . . . inoperative. Naturally, there is no smoke.

LEFT: This stack is "hot" . . . in operation at a large Eastern utility. Smoke? There never was any! Since the station has been on the line, an efficient Koppers precipitator has been on the job.

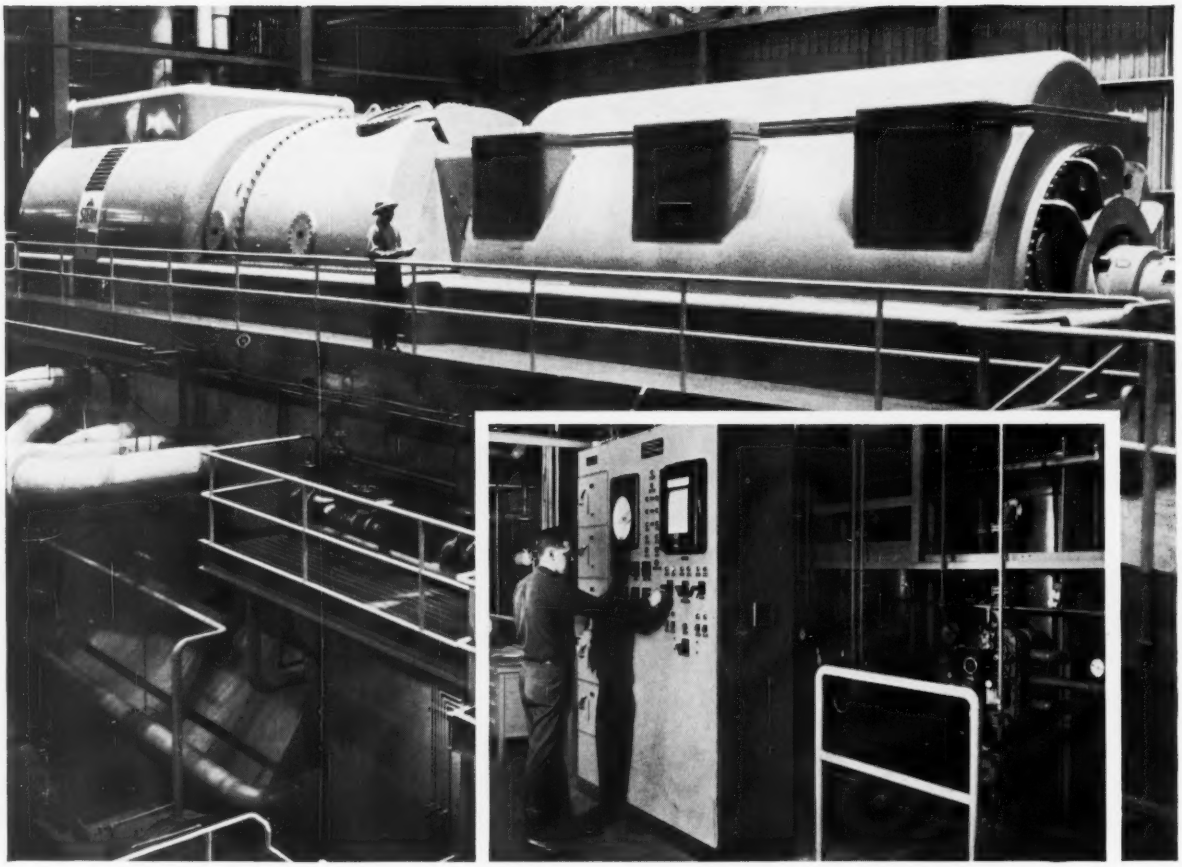
Call Koppers—a leading manufacturer of gas cleaning equipment for industry.

**Facts available on request*

KOPPERS

ELECTROSTATIC PRECIPITATORS

Engineered Products Sold with Service • Baltimore 3, Maryland



INSET: Ion exchange units and control panel at Mt. Tom Power Plant of Holyoke Water Power Company, Holyoke, Mass.

AMBERLITE® resins deionize organic-bearing water for high pressure boilers

Here are the results AMBERLITE ion exchange resins are producing at the new Mt. Tom Power Plant of the Holyoke Water Power Company: Water source—well water high in organic content, 107 ppm total ion concentration, 25 ppm silica. Water after ion exchange treatment—conductivity less than 1 micromho, silica 0.004 ppm. Treated water is used in 1950 psi boilers.

Water pretreatment consists of superchlorination, then filtration through activated carbon. Ion exchange takes place in a 4-bed demineralizer system consisting of a primary unit and a polishing unit. AMBERLITE IR-120 is used in the cation units, AMBERLITE IRA-402 in the anion beds.

AMBERLITE IRA-402, a highly porous resin, has particular value in the system because it provides ready absorption of large organic molecules and releases them more easily during regeneration than do resins of standard porosity. At Holyoke, removal of foulant accumulated on AMBERLITE IRA-402 after repeated regenerations is accomplished by treatment with brine and caustic.

If you use water for chemical processing or power generation, Rohm & Haas' wide selection of AMBERLITE ion exchange resins may offer you cost-saving advantages. Write today. We will be glad to send you more information.

Folder available free, shows how many different industries use AMBERLITE ion exchange resins for specific applications. Address your request to Dept. IE-1.

ROHM & HAAS

PHILADELPHIA 5, PA.

AMBERLITE

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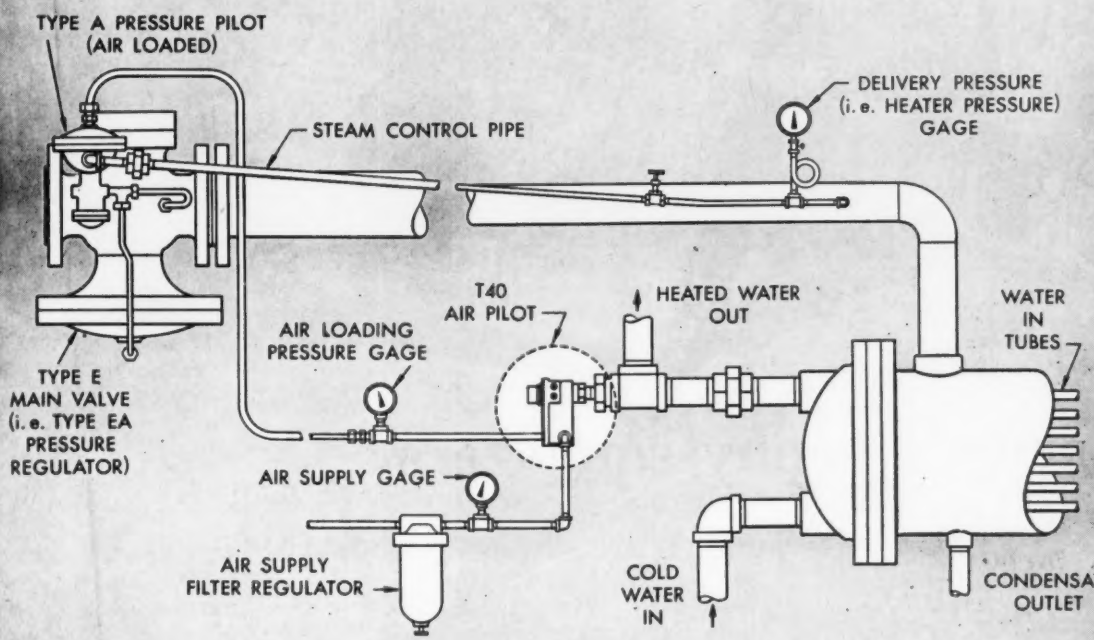
(*Advertisement*)

VALVE TIPS:

New Spence Temperature Control System Gives Unusual Control Accuracy


TYPE A PRESSURE PILOT (AIR LOADED)
STEAM CONTROL PIPE
DELIVERY PRESSURE (i. e. HEATER PRESSURE) GAGE
T40 AIR PILOT
HEATED WATER OUT
WATER IN TUBES
AIR LOADING PRESSURE GAGE
TYPE E MAIN VALVE (i. e. TYPE EA PRESSURE REGULATOR)
AIR SUPPLY GAGE
AIR SUPPLY FILTER REGULATOR
COLD WATER IN
CONDENSATE OUTLET

TYPE EAT40 AIR-CONTROL TEMPERATURE REGULATOR (Patent Pending)

In a recent installation the new Spence air-control temperature regulating system provided:

- ±5°F control accuracy under wide and instantaneous load swings of 210 to 80 gallons per minute.
- Up to 50% reduction in cost as compared to instrument systems of similar accuracy.

This unique cascade-type control with throttling range adjustment independent of maximum heater pressure was developed to meet today's demand for greater control accuracy.

Additional features of the new Spence Temperature Control System include:

- 200°F wide adjustable temperature range
- Adjustable speed of steam pressure change
- Over and under temperature protection
- Pressure limit control
- Fast response
- Very low air consumption
- Field reversible for heating or cooling

The Spence Type EAT Air Control Temperature System, when properly installed, will tame wide ranging, fast changing loads of instantaneous heaters and modern heat exchangers. The cascade principle plus the use of an extremely fast responding bi-metal temperature sensing element reduce time lags and provide control stability.

Here's how the new Spence system operates:

Quick response is based on a bi-metal temperature sensing element.

Temperature pilot continuously regulates a loading air pressure.

This loading signal, when applied to a pressure regulator to reflect heater temperatures, causes it to adjust the main valve as changes in load require.

Spence has also developed a new pressure control system based on this same cascade principle. This system has a control accuracy of ½ psi or better from positive pressures through the vacuum range to 30" Hg.

For complete information on these new air controlled temperature and pressure control systems, write for your copy of Bulletin 9.

SPENCE ENGINEERING COMPANY, INC.
Walden 1, New York SE-140

"I'm Marmaduke Surfaceblow, on my way to British Columbia to look over a deep-sea fleet for a Creek sea-food combine," said the stranger

Marmy's penny squeezers

"I got the packing-company contract, Olson ol' kid," warbled Joe Warburg as he rushed into his office, "and I just learned we bid $29,430 less than the next lowest bidder. Wow," he yelled jubilantly, "how's that for making a fast buck? Let's go out and burn up the town!"

"Great; now we can pay the rent," laughed hard-boiled Harold Olson, slapping his partner on the back. The two men started thumbing hurriedly through the specs in the bundle Warburg had thrown on his secretary's desk.

"Hell," exploded Olson after a few minutes, "I can see a dozen places where we'll get the 30 grand back and still make as much as that Nicholson outfit we outbid. But, boy, that packing company sure writes a sloppy set of specs. Must have been done by some junior draftsman instead of the refrigeration-department engineers. Or maybe it was the office boy."

"That's not the reason," explained Warburg. "Sam Bently, their VP, is the worst penny pincher in Nebraska. He's funny about contracts; can't see further than his nose. Long as he gets a low original price he doesn't worry about what it costs him later. If we put in that plant as it should be our bid would be higher than the Nicholson one. The only way to deal with that cheapskate is to bid low enough to get the contract, then cut all the corners in the book to clean up on the deal. And that's exactly what I figured on."

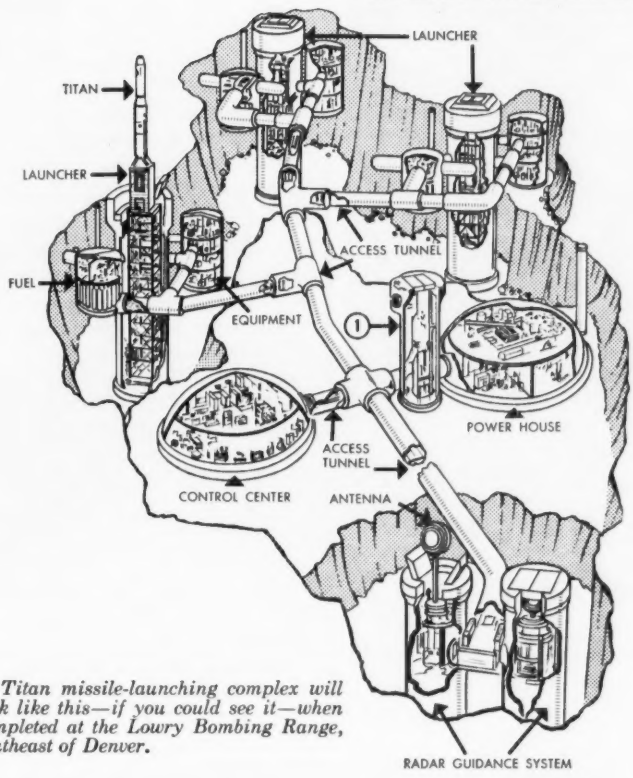
"Sure, and add a few new corners they never heard of," laughed his partner. "It's their plant and if they want price, not engineering, we'll give them a rock-bottom price. After all, we're following their specs—and we gotta eat."

"Well," suggested Warburg, throwing himself down into his swivel chair and propping his feet up on his desk, "now that we've got the contract, let's get our boys on the job by the 17th. We should have that plant buttoned up and ready to roll by the time the building's complete. After that it's their baby."

Three weeks after the dedication of the new packing-company building a

PUMPAGE

Goulds news about pumps for process industries



A Titan missile-launching complex will look like this—if you could see it—when completed at the Lowry Bombing Range, southeast of Denver.

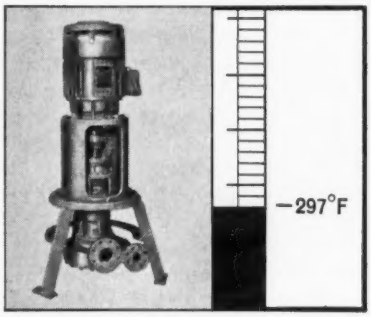
Goulds ductile iron pumps help build TITAN MISSILE MUSCLE

Deep under the Colorado earth, two gigantic Titan missile bases are taking shape. Powerhouse and control center are vast domed structures. Three two-story structures will store fuel. Four-story cylinders will house monitoring and other operating equipment.

Immense and complex, the bases require a wide variety of pumping services. Goulds, the major pump supplier, is building hundreds of units —from vertical sump pumps to high-temperature, high-pressure units.

Many of the pumps *must* be able to stand severe shock so we are making these, or their critical parts, of ductile iron. Castings range from ½ lb. to over 1800 lbs., making up probably the largest order for ductile iron pumps ever placed.

If you'd like to know why ductile iron has unusual resistance to stress, impact, and high pressures, send for Bulletin 765.7.

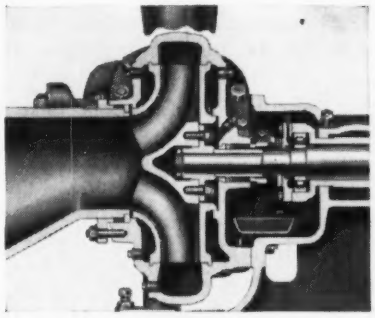


How to pump cryogens

One company pumps liquid oxygen at −297°F with this process pump.

Model 3181's basic design especially fits it for low-temperature pumping. Casing arrangement of suction limits pressure on column, bearings and seal to vessel pressure only. Special magnetic mechanical seal seals shaft.

Cryogens raise special problems in selecting pump design, materials, and seal. Our engineers, experienced in these applications, can help you. Write us.

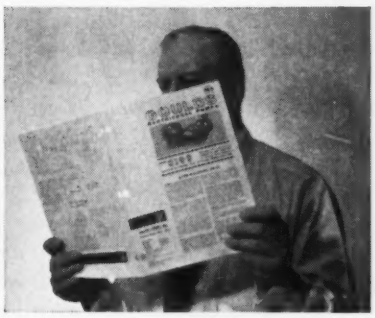


Cotton pickin' pump

Nine Model 3135s pump cotton linter stock *in a smooth flow* for Southern Chemical Cotton Co.

The fine cotton fibers can't clog the open end suction impeller. Ejector vanes on back wall of impeller follow curvature of main vanes, prevent entrance and jamming of stock between wall and stationary sideplate. There is no impeller nut or other obstruction at the impeller eye to catch fibers.

For specifications and performance data, send for Bulletin 723.1.



Now...small-capacity pump for chemicals and slurries

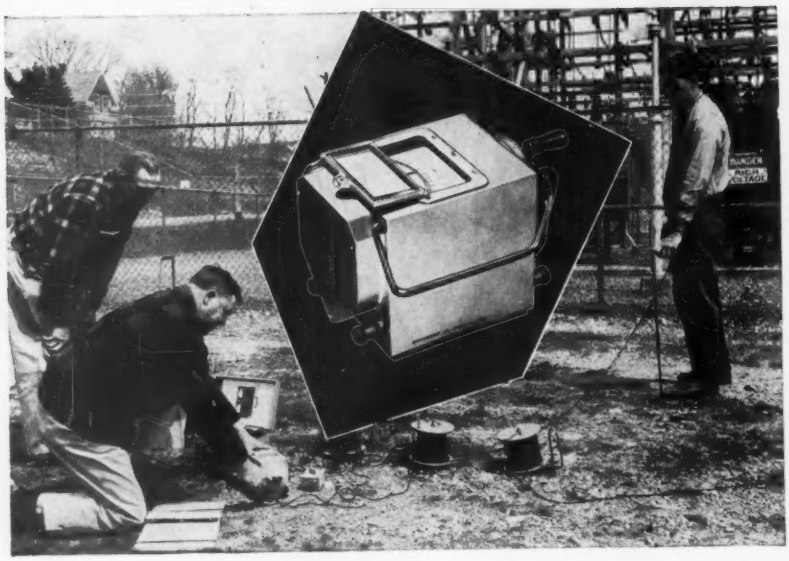
Handles up to 115 gpm of corrosive chemicals, thick or abrasive slurries at heads to 150 ft.

Of single-stage side-suction open-impeller design, Model 3199 has hydraulically balanced impellers with ejector vanes on back wall to keep out solid material and reduce stuffing-box pressure. Bearings are isolated in cooling chamber.

For specs, ratings and other data, write for Bulletin 720.5. Goulds Pumps, Inc., Dept. PO-41, Seneca Falls, New York.

GOULDS GP PUMPS

For more facts circle 284 on Reader Service card, p 101

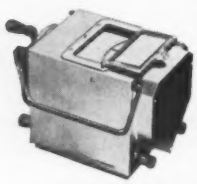


UTILITY PREVENTS ELECTROLYTIC CORROSION—RELIES ON MEGGER® GROUND TESTER

Worcester County Electric Company's underground cable system in central Massachusetts was the target of severe corrosion caused by low ground resistance to stray electrical currents, until laboratory tests revealed the situation.

After acting quickly to repair the corroded sections, the utility embarked immediately on a preventive maintenance program to stop further deterioration. The program was built around continuing tests with a Megger Ground Tester, selected because of the speed, ease and accuracy it provides in obtaining readings.

After a year's use, Worcester Electric finds that the Megger Ground Tester gives these advantages:



1 *It functions at all times*
2 *It does not have to be balanced*
3 *It does not require a power supply*
4 *It requires a minimum of maintenance*
5 *It takes rapid, accurate readings*

Savings attributed to the Megger Ground Tester preventive maintenance plan run into thousands of dollars per year. Worcester Electric is now able to spot areas of low resistance in their cables sufficiently in advance of actual breakdowns so that complete counteracting measures can be taken.

DO YOU HAVE THIS INFORMATION FILE ON GROUNDING ?

The James G. Biddle Co. File 25 is an excellent fund of information on grounding problems. It includes a manual on Ground Resistance Testing, and bulletins on "Grounding Electrical Circuits Effectively" and "Grounding Principles and Practices Applied to Industrial Plants." B1016

Write Now for Your Copy of Ground Testing File 25P.

BIDDLE INSTRUMENTS

JAMES G. BIDDLE CO.
Electrical & Speed Measuring Instruments
1316 ARCH STREET • PHILADELPHIA 7, PA.

Marmaduke

Begins on page 138

dilapidated-looking Packard of ancient vintage pulled up to the Fontennelle Hotel in Omaha, Neb. It was late on a Sunday evening in autumn. Suddenly a large character jumped out of the car, tossed his bag onto the sidewalk and slammed the car door shut. He wore a loud checkered vest and a gray derby set at a rakish angle atop his head. There was a devil-may-care look on his leathery face as he puffed away on a cigar butt.

Looking neither to left nor right, the stranger jerked a thumb towards his bag on the sidewalk as he passed the uniformed doorman, then disappeared quickly inside the swanky hotel. He checked in, flipped a coin to the bellboy and told him to take his bag upstairs.

"Where's your bar?" he roared to the room clerk. "I gotta ballast my tanks before turning into the sack."

The hotel bar was filled with the usual Sunday-night after-theatre crowd of guys and gals. Most of them seemed to be having a good time. The hostess showed the new arrival to a table in one corner of the large crowded room. Next to his table was a noisy party of six men, going at it hot and heavy. They were arguing about refrigeration machinery in the local meat-packing plant.

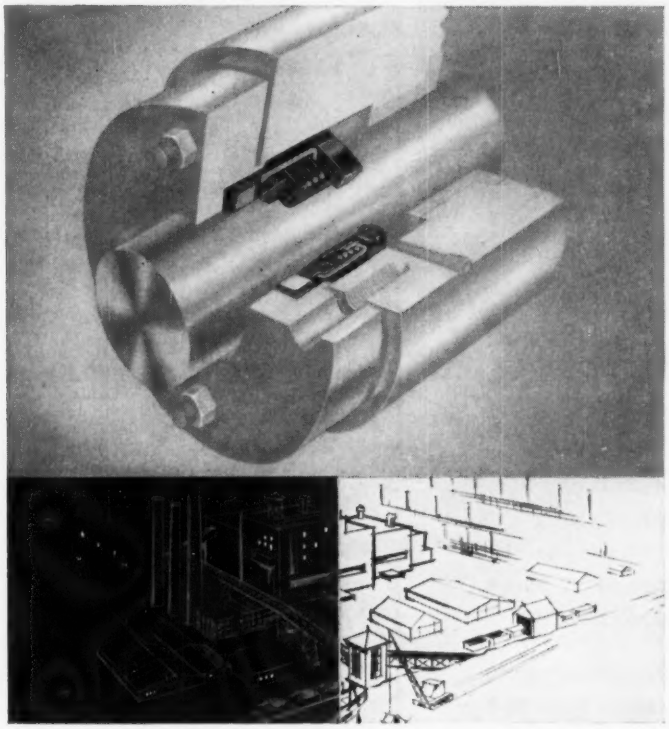
As the argument got loud, the stranger introduced himself. "I'm Marmaduke Surfaceblow from New York City," he told them, "on my way to British Columbia to look over a deep-sea fleet for a Greek sea-food combine. I hate to intrude, but your problem interests me. I've quieted unbalanced, jittery and slap-happy machinery all the way from Chillicothe to Baghdad. Besides, I can always use a few pesos."

"You can only do us good," piped up a little man dressed in snappy evening clothes. "We're at the end of our rope. I'm vice-president of the packing plant and fed up with paying for useless improvements." Then he introduced his companions to Surfaceblow. They were his plant engineer, chief engineer, a local machinery contractor, an architect and the sales engineer for an ice-machine firm in Chicago.

continued

ENGINEERED PRODUCTS

for Plant Maintenance



Garlock PK MECHANIPAK Seals work night and day to stop leakage, reduce downtime, and cut maintenance costs on centrifugal pumps and similar equipment.

For 'round the clock prevention of leakage on rotary shafts, apply Garlock PK MECHANIPAK* Seals.

Specified as standard by many industrial companies and utilities, Garlock PK MECHANIPAK Mechanical Seals also help protect equipment from failure in many high temperature applications.

Plant engineers and maintenance personnel enjoy the ease with which Garlock PK MECHANIPAK Seals are handled and installed. A self-contained "package" unit, the seal has no parts that must be put together. The rotating portion simply slides onto the shaft; the stationary portion positions quickly into the counterbore of the gland. Once the Garlock PK MECHANIPAK is installed, further adjustment is unnecessary. No parts of the seal move on the shaft or sleeve, eliminating wear to these parts. A spring in the seal maintains contact between sealing faces, thus assures leak-proof operation.

To meet the various application conditions encountered on centrifugal pumps and similar equipment, Garlock PK MECHANIPAK Seals will operate at pressures to 150 p.s.i., and in temperatures as high as 212° F with Buna-N bellows . . . above 212° F with fluid at faces and Viton† bellows. The standard seals can be applied on shafts from $\frac{3}{8}$" to 3" in diameter, with speeds up to 2000 f.p.m. and are available for "off-the-shelf" delivery. Garlock PK MECHANIPAK Seals will work effectively against water, oils, alcohol, mild acids and solvents. Where application conditions are more extreme (i.e., higher temperatures, shaft speeds, or pressures) Garlock PK MECHANIPAK Seals are available in several different materials, each suited to a particular requirement.

For the complete story, get in touch with the Garlock representative in your area. Call him at the nearest of the 26 Garlock sales offices and warehouses throughout the U.S. and Canada. Or, write for Catalog AD-150, Garlock Inc., Palmyra, N.Y.

GARLOCK

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Order from the Garlock 2,000 . . . two thousand different types of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Products.

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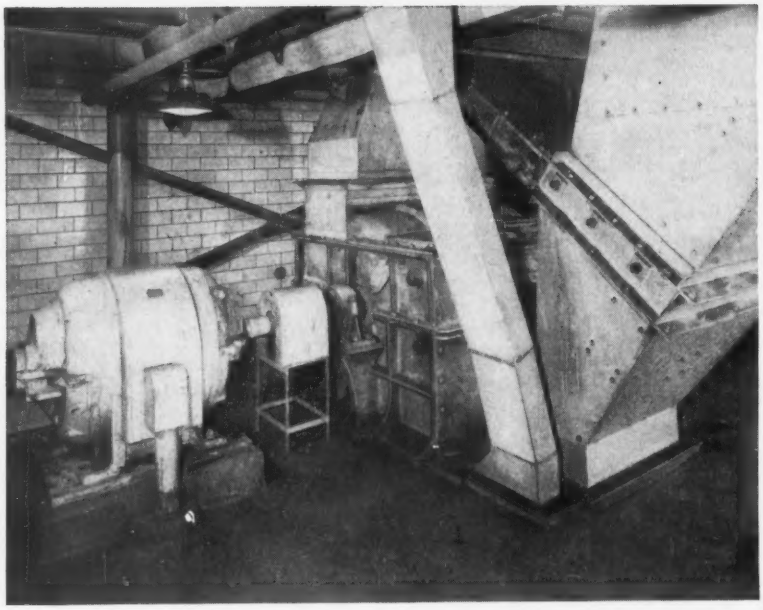
CRUSHING FACTS



American "Rolling Ring" Coal Crusher

splits coal! . . . smashes maintenance costs!

In almost five years, the above American Coal Crusher has reduced 1,800,000 tons of 2" x 0" coal to a ¾" x 0" product for a prominent midwestern utility. Since installation, this unit has handled an average annual tonnage of 450,000, with a very low ratio of replacement parts to tonnage. The operating engineer for this utility says, "We have experienced no stoppages . . . crusher operation and maintenance have been very satisfactory."

"Rolling Ring" design makes the difference. Specially designed rotor, consisting of four rows of patented shredder rings, each suspended on a single shaft, rotate freely at a relatively *slow speed.* Coal is *split* rather than smashed. This splitting action saves both power and maintenance, gives more uniform sizing, fewer fines. Rings can be reversed to give extended life.

American has manufactured reduction equipment since 1908 and you can be sure that "When you figure costs, the best results come from American *Rolling Ring* Crushers." If you have a coal preparation problem, why not write today for recommendations and literature. Our highly-trained engineering staff will give you prompt assistance.

American PULVERIZER COMPANY

ORIGINATORS AND MANUFACTURERS OF RING CRUSHERS AND PULVERIZERS

1349 MACKLIND AVE. ST. LOUIS 10, MO.

Marmaduke

Begins on page 138

"Frank," called the VP to the waiter, "move this gentleman's refreshments to our table." Then chairs were shifted, making a place for the big man. Soon as he sat down, the plant engineer briefed him on the problem.

"Our plant is a new 3-story building, covering an entire city block," explained the plant engineer. "We moved in only three weeks ago. The refrigeration room is in the basement and the offices directly above. Main causes of trouble are a 15x10 booster and a 2-cylinder 10x10 ammonia compressor. Both machines are driven by synchronous motors at 360 rpm. When those two units run together the vibration is often so bad that, on the floor above, the office help's teeth chatter. And I'm not just talking.

"We've tried all kinds of schemes since moving into the building. Two weeks ago the machines were lifted and mounted on rubber vibration pads. That reduced the noise a little, but the machines vibrated more violently."

"Your flexible mountings allowed them to reach a critical condition," Surfaceblow cut in. "It was a case of being near resonance with their operating speed of 360 rpm. So your story has a familiar ring, or should I say vibration," he laughed. Then he added, "I'll look in on your headache first thing in the morning. I know I can tame that equipment. But my fee is $500, and I mean to collect on the spot." There was a slight pause, then the VP spoke up.

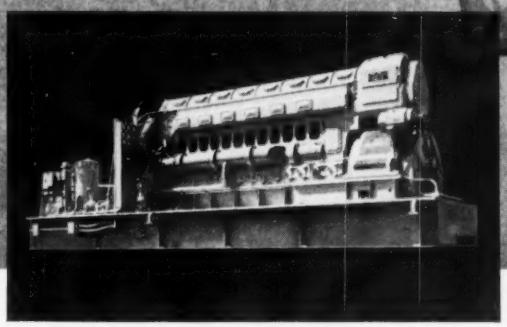
"You seem pretty sure of yourself, Mr Surfaceblow, but how long will we have to shut down before our galloping compressors keep quiet?" he asked thoughtfully.

"About two weeks, if you follow my plans," answered Marmaduke.

"No good," shot back the VP promptly. "We can't shut down that long right now. This is our busy season and we must keep running at top capacity for the next three months. But if you're as good as you say you are," he challenged, "why can't you stop that vibration temporarily until we *can* shut down?"

Before Surfaceblow could answer, the VP added, "to make it worth your

NOW! FULL POWER IS 15 SECONDS FAST!



Solve peak-load and standby problems! F-M's exclusive O-P Diesel Generating Units provide *full* power in 15 short seconds . . . *from a cold start!* They need no spinning reserve. Use no power till you use them! The reason? Our exclusive O-P (Opposed-Piston) design. Two pistons in one cylinder function from a *single* combustion. This minimizes *vibration* . . . produces fine *balance*, *smooth* power to peak the generator—in just 15 seconds! F-M Opposed-Piston Diesel Generating Units are available with automatic or manual controls. Produce up to 2500 kw. They may be linked in multiple units for peaking, standby duty . . . or dead load pickup! You can't buy better—or more economically.

For full details or custom specifications, write today to: **Mr. S. K. Howard; Diesel Division; Fairbanks, Morse & Co.; Beloit, Wisconsin.**

FAIRBANKS MORSE

A MAJOR INDUSTRIAL COMPONENT OF

FAIRBANKS WHITNEY

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MERCOID®

LOW PRESSURE CONTROL

FOR AIR OR GASES

New low pressure diaphragm control for gases or air. Can be used three ways; for pressure, negative (vac.) pressure or differential pressure.

Two operating ranges, 1.0″ to 30.0″ and 1/2 to 5 psig.

External Adjustment
Sealed mercury contact
Visible calibrated dial
Visible on-off circuit
Repetitive trip point

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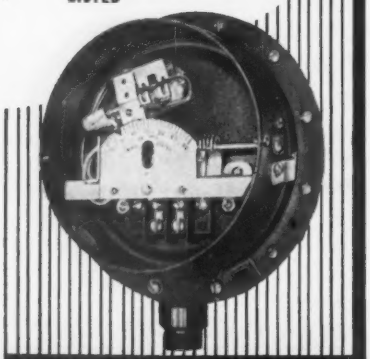

THE MERCOID CORPORATION
4201 Belmont Ave., Chicago 41, Ill.

circle 289 on Reader Service card, p 101

Marmaduke

Begins on page 138

time I'll raise your ante to $1000. Then we can put in your permanent cure during our slack season."

Marmaduke seemed to open his mouth to say something, but he was stopped in his tracks and everyone knew it. Then he suddenly brightened up. "EUREKA," he yelled in his foghorn voice, "can do! I'll be at your plant at eight in the morning." With that he emptied his glass in one gulp and barged out of the bar before his startled audience could ask him questions about his plans.

Next morning, soon as he saw the machinery in operation, Marmy knew he had that $1000 stowed away in his pocket. Just as the plant engineer had explained, the whole building shook. It was awful. The worst case of poor engineering and penny pinching he had ever seen in a new plant. At least that is what he told the watch engineer. And there was plenty of evidence that the packing company was already paying through the nose by trying makeshift remedies. They had haphazardly added discharge-line snubbers, had even rearranged the discharge piping.

A quick inspection told Marmaduke that the automatic synchronizing gear on the motors fell into step on the same piston-stroke position of both machines. He disconnected the auto-synchronizer on one unit and connected an ammeter across phases between the two units. After experimenting, he found that there was enough current surge indicated to help him synchronize the two units out of step with each other in relation to their piston position. Soon as he did that the vibration and noise stopped almost completely. Quiet settled over the plant.

Members of the engineering department and people from offices upstairs started streaming into the machinery room to see what was wrong. "Don't tell me this scrap iron is running quietly," yelled the VP as he came barging through the door on the double and saw the machines cranking away. "What did you do?" he asked in amazement.

By then there was a circle around Marmy and he was being bombarded with a round of questions. "Long as

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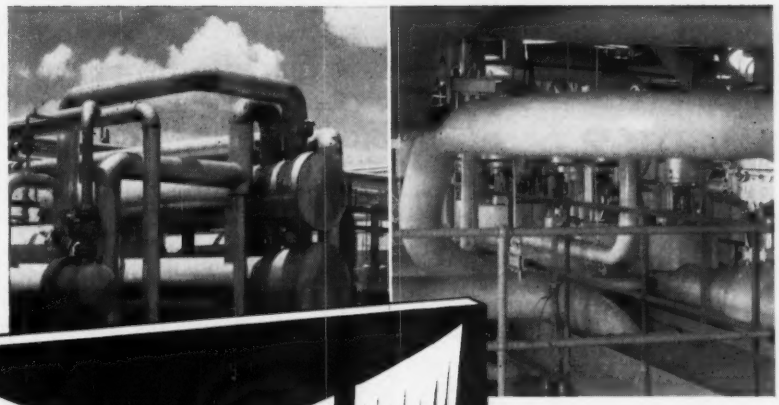

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YOUR MOST DEPENDABLE SOURCES FOR MEETING EVERY EXACTING PIPE FABRICATING SPECIFICATION

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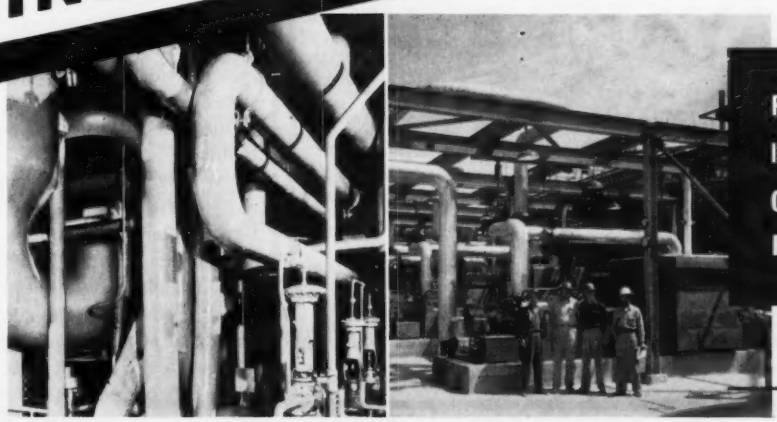

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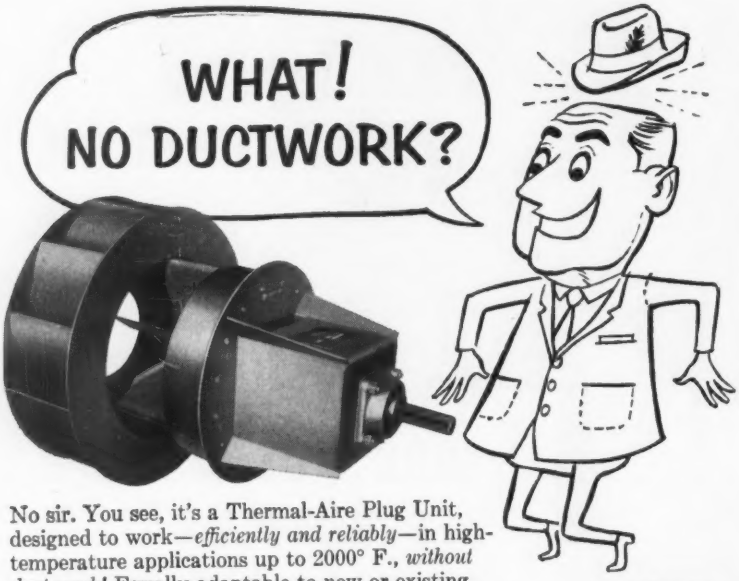
For more facts circle 290 on Reader Service card, p 101



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THERMAL-AIRE PLUG UNITS

Garden City Fan & Blower Co. N. Eighth St. Niles, Michigan

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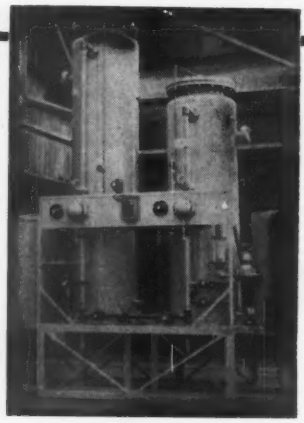

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CLAYTON 3, NEW JERSEY

Marmaduke

Begins on page 138

synchronization is done by hand, at a known relative position of the compressor to booster," he told them, "vibration and pulsation will be about nil. But just as I reasoned last night at the bar, when these two units are automatically synchronized in step by instrument, one unit complements the other and vibration begins to soar. To make things worse, the compressors are side by side. That builds up a couple, adding to the problem.

"After you get over your production hump and can shut down these machines," Marmy suggested, "here's the permanent cure. These two machines are side by side, bolted down onto a common concrete base. Move them in line to do away with the couple effect. Then dig out under their base and put each machine on a large floating-mass inertia block, mounted on steel springs damped by rubber. We can work out the details in your office upstairs."

"You've earned your fee," announced the VP happily, still looking with disbelief at those machines quietly cranking away at top speed.

"Before you leave the plant engineer's office, Mr Surfaceblow, stop by and I'll have your loot ready; in handy nickels, dimes, 10-dollar bills or check, as you prefer."

Six months later the VP and his plant engineer were lunching in the Fontennelle Hotel bar. "You know, Bob," suddenly said the VP, "I just thought of that character we met here one night who stopped our compressors from vibrating. Remember him?"

"Sure do," replied the plant engineer. "His name was Marmaduke Surfaceblow and we followed out all his recommendations. Of course I suggested some of those improvements in the first place, but no one listened to me."

"What did all those repairs finally cost us, Bob?" asked the VP with a faraway look in his eyes, not even hearing his engineer's first answer.

"Oh, about $35,000, if you add in the shutdown time and some spoilage while that work was going on."

"He sure was a queer character, eh Fred?" commented the VP, almost

For more facts circle 292 on Reader Service card, p 101

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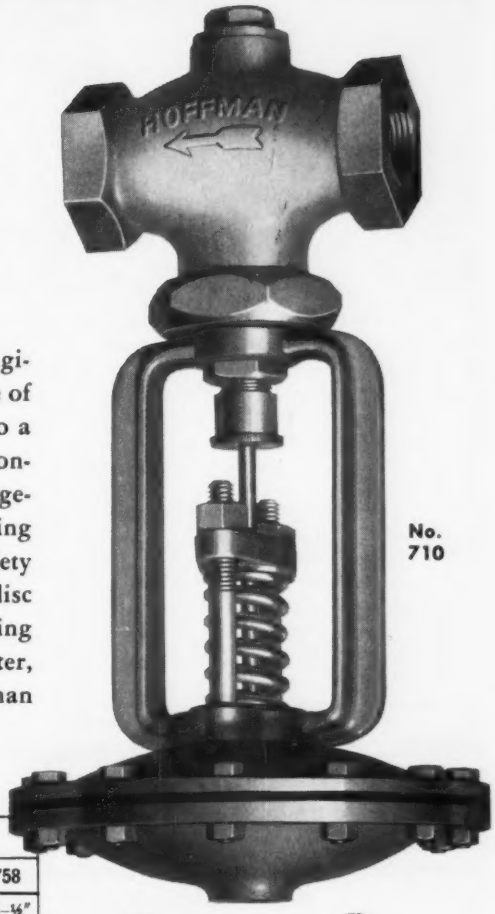

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No. 750

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PRESSURE REDUCING VALVE SELECTION CHART

	700	710	715	720S	720W	740	750	758
SIZE—Inches	½–8″	½–1½″	2–4″	¾–6″	¾–6″	½–8″	½–1″	¼–½″
MAX. INITIAL PRES. PSI	200	250	250	250	250	250	250	300
MAX. REDUCED PRES. PSI	15	80	125	125	15	125	125	180
MIN. REDUCED PRES. PSI	1	5	5	15	2	5	2.5	5
STEAM SERVICE								
WATER SERVICE							*	
AIR SERVICE							*	
GAS SERVICE								
OIL SERVICE								
SINGLE SEATED								
DOUBLE SEATED								
SPRING LOADED DIAPHRAGM								
WEIGHT & LEVER								
CONTINUOUS SERVICE								
DEAD END SERVICE								

*When specified, diaphragm must be changed from phosphor bronze to rubber.

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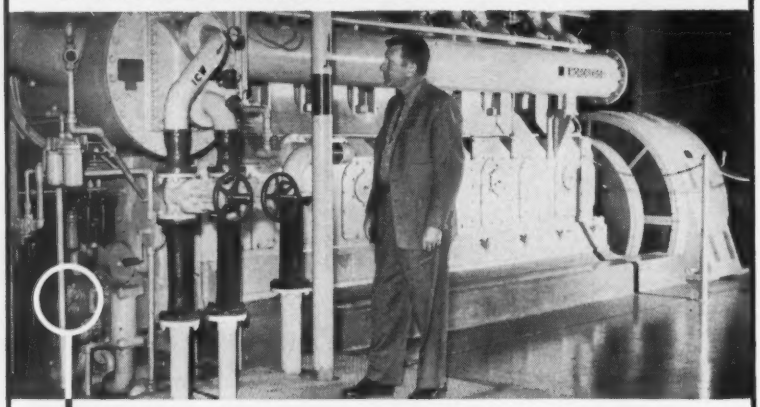
For more facts circle 293 on Reader Service card, p 101

EVEN MISSILE BASE POWER UNITS USE VIKING PUMPS



WHEREVER smooth, dependable pumping is required, you're apt to find VIKINGS. No wonder, then, that VIKING PUMPS were used on the Nordberg diesel generating units at Vandenberg Air Force Missile Base in California. The base must always be ready to launch its Atlas guided missiles without fail and the generating plant insures an independent, dependable source of power for this purpose. Lubrication to each of the six Nordberg engines in the 8000 horsepower, 5700 kw plant is supplied through VIKING PUMPS.

For the most dependable pumping equipment available, specify VIKING PUMPS. Used integrally or as independent units, VIKING PUMPS can be depended upon for efficient service and long life. For information, write for catalog 61SW . . . VIKING PUMP COMPANY, Cedar Falls, Iowa, U.S.A. In Canada, it's "ROTO-KING" PUMPS. See our catalog in Sweet's Industrial Construction and Plant Engineer's File.

50 YEARS

For more facts circle 294 on Reader Service card, p 101

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to overcome draft shortages, permit increased firing rates

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FIELD CONTROL DIVISION

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For 5"—34" Flues

For more facts circle 295 on Reader Service card, p 101

Marmaduke

Begins on page 138

talking to himself. The plant engineer shot a quick, penetrating look at his boss. "Yeah, mighty queer," was all he could say. Then he lit a cigarette and blew a large cloud of smoke toward the ceiling. *SME*

Marmy's Mailbox

'Tis here you exchange blasts with the old boy

LIGHT REFRESHMENT

As a bit of light refreshment I do enjoy Marmaduke Surfaceblow. Please let me know who are your local agents in Sydney and if they would have copies of the Marmy stories. I hope the old salt never has to pay his final account in my lifetime. Judging by the comments in POWER, others feel as we do here. With good wishes to both POWER and Marmy.

A F PAIN, *Sydney, Australia*

MARMY FASCINATES

The Marmaduke Story leads me to believe that the author must be a fascinating bundle of conflicts. It's such delightful fanciful whimsy coming from the heart of a solid technical magazine like POWER.

R K ROCKWELL, *Providence, R. I.*

MARMADUKE DEVOTEE

Marmy is the only detective-story series I read. He can trace out a complicated problem from the thinnest clue.

B WOOD, *London, England*

WANTS MARMY IN PLANT

After reading the Marmy yarns for years, I often wish he were available. I've run into several experiences that would make his help most welcome.

J A FULLER, *Riverside, Calif.*

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Whether gunited or plastered, installation is easy and economical, with concrete reaching service strength in 24 hours. For even greater convenience, manufacturers of refractories offer castables bonded with LUMNITE cement – packaged mixtures ready for use with just the addition of water.

For more information, write Universal Atlas Cement, 100 Park Avenue, New York 17, N. Y.

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INSTALLATION: Elrama Station, Duquesne Light Company, Pittsburgh, Pa.

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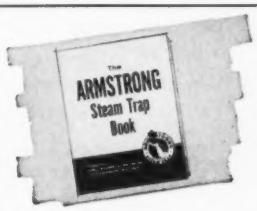

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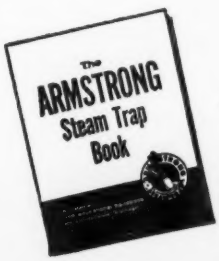

The 48-page Armstrong Steam Trap Book tells how to correctly size, install and maintain steam traps for any pressure, any temperature, any load plus full catalog data on Armstrong Steam Traps. Ask for Catalog K.

ARMSTRONG MACHINE WORKS

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For more facts circle 298 on Reader Service card, p 101

Powerscope . . . A selective look at

New utility service

The Hartford Gas Company in Connecticut is installing a central water-chilling plant with an initial capacity of 6500 tons of refrigeration and 150,000 lb of steam an hour. Chilled-water supply and return lines two ft in diameter and steam supply and return lines one ft in diameter will extend some 3600 ft from the plant. Carrier Air Conditioning Company is supplying one 3000-ton and two 1500-ton steam-operated centrifugal-cooling units plus one 500-ton steam-energized absorption-cooling machine. The system will serve a cluster of three office buildings, one hotel, a broadcasting facility, a shopping center and the office buildings of a major insurance company. The Gas Company foresees an ultimate capacity of 10,000 tons of refrigeration needed in its plant. Initial investment is estimated at $3 million for the central plant and two miles of steam and chilled-water pipelines, expected to be ready next year. In four years, annual revenues are expected to range about $1 to $1.5 million.

Thermoelectric generators at work

Northern Illinois Gas Company has bought a 100-w thermoelectric generator built by Westinghouse Electric Corp. Unit will be used for cathodic protection of pipelines, for charging batteries for microwave relaying equipment, meters and valve controls. Two 50-w sections stack one on the other. Propane gas burning in the base of the unit generates hot gas to pass through a central insulated chimney. Couples mounted around the chimney generate electricity. Their hot side runs at 750 F; the heat dissipates through anodized aluminum fins to the air. Unit weighs about 75 lb. The generator produces 10-amp dc at 11 v and a static converter with 88% efficiency changes this to 2.1-amp dc at 48 v. The gas company foresees possibility of using advanced form of these to generate power for driving fan motors on gas furnaces.

New installation exam

In extending the certification of mechanical personnel in the oil-heat industry, the Education Committee of the Oil Heat Institute of America has approved a draft outline of an installation certification examination. Final version may be ready for the 39th Annual Convention of the OHI on April 23 to 27, 1961 in Washington, D.C. The new exam will be made up of a number of main sections covering general principles, warm-air systems, hydronic systems, accessories, conversions, etc.

Highest temperature

The Lawrence Radiation Laboratory of the University of California has achieved a controlled thermonuclear reaction that produced a temperature of 60-million F, the highest yet. The plasma of deuterium was forced by pulsed magnetic fields into regions of higher-strength magnetic fields in a magnetic-mirror machine. Every step increasingly compressed and heated the plasma. The machine held the plasma in the volume and shape of a football at the top temperature for about 1/1000th of a second, the longest time up to now. But we're still quite a way from a practical fusion-power generator.

Bigger and bigger

The world's largest generating unit went into commercial operation on February 1 at TVA's Widows Creek Steam Plant. The new unit, seventh in the plant, has been producing 535 mw and is expected to go to over 550 mw. It raises the plant's rated capacity to 1175 mw and installed capacity of the TVA system to 11,885 mw.

Third gas-turbine standby plant

The South Western Electricity Board has ordered a third Bristol Siddeley 3-mw gas-turbine unit for installation at Porlock in Somerset, England. Like the two units now in service, this will be fully automatic and run under remote control by telephone from a central control point. The unit uses a modified version of the Bristol Siddeley Proteus turboprop aircraft engine, power plant of the Britannia planes, rated at 4250 hp. The unit can be used as a mobile plant and needs no outside water supply. They claim it need be visited only once a month for checking.

New circuit breakers

The TVA has ordered three 13.8-kv stored-energy air-magnetic circuit breakers from the I-T-E Circuit Breaker Company. These will have the highest interrupting and closing capacities of their type—1500-mva interrupting and 100,000-amp closing. The breakers will be shipped this year for installation at Wheeler Dam power station on the Tennessee River between Florence and Decatur, Ala. They will feature stored-energy spring-closing mechanisms and a new design in arc transfer and interruption. This makes them smaller in size, lighter in weight, gives them a low center of gravity.

this month's power-field happenings

B G A SKROTZKI, Associate Editor

Unconventional power group

The National Electrical Manufacturers Assn have organized a new Unconventional Power Generation Section. Its scope: magnetohydrodynamics, fuel cells, thermoelectrics, thermionics, batteries, photovoltaics and photochemicals. Early projects will probably deal with government contracts and the development of standards for basic terms, definitions and tests. Invitations will be extended to companies in this field not now members of NEMA to join and affiliate with the new section.

Action on air pollution

Dr J T Middleton, chairman of the California State Motor-Vehicle Pollution-Control Board, told the Advisory Council of the Bay Area Air-Pollution-Control District (San Francisco) that the cooperation of counties and air-pollution-control districts is vital to fulfill the state's anti-auto-smog program. Some 70 companies have requested application forms from the State Board to have their anti-auto-smog devices tested, and the Board should certify two or more devices this year, said Dr Middleton. All new cars in the state would then be equipped with devices by 1963 and used-car emissions would be controlled by 1964. Individual counties, however, may vote themselves out of the law for used cars.

Old plant to double rating

Philadelphia Electric Company has announced plans to install four 65-mw units in its present 7-unit 252-mw Conowingo hydroelectric station on the Susquehanna River in Maryland. The new units will use four penstocks available in the existing dam. At the time it was completed in 1928, Conowingo was the largest plant built in one step. The new units will start in 1965 subject to FPC approval. Conowingo now produces about 10% of the annual PE consumption.

Canadian CO boiler

The British American Oil Co, Ltd is installing a $1-million carbon-monoxide boiler and extraction-steam turbine at its Clarkson refinery, 20 miles west of Toronto, Canada. The CO boiler will evaporate 165,000 lb of steam per hr at 600 psig and 750 F. The 6000-hp extraction turbine, first of its kind in Canada, will replace the main electric motor in the catalytic cracker. The CO boiler aids heat recovery and disposes of waste gas by burning CO and unburned hydrocarbons produced in the refinery's catalytic-cracking operation. Boiler is built by Combustion Engineering, Inc and the turbine by Canadian Westinghouse Co, Ltd. Project is scheduled to start this fall. (*McGraw-Hill World News*)

One for four to double

Pacific Gas and Electric Company is building a new Stanislaus Powerhouse on the Stanislaus River 300 ft downstream from the existing plant. The 52-year-old plant has four generators with a total capacity of 40 mw; these will be replaced by a single outdoor 82-mw unit in the new plant, to start running in the fall of 1962. Existing 11-mile tunnel will be extended by a 4407-ft penstock, 9-ft 10-in. diameter at top tapering to 7-ft diameter at bottom. The plant will remain one of the highest-head plants of the 63 on the system—1526 ft.

World's fastest breakers

American Electric Power System has ordered five of the fastest air-blast circuit breakers yet built from General Electric Company. The 345-kv breakers will clear short-circuit currents as high as 25-million kva in two cycles, compared to existing three cycles. It will be installed next year. Lightning-induced short-circuit arcs and system disturbances will be snuffed out automatically by blasts of self-replenishing high-pressure air stored in the breakers' interrupting chambers. Faster clearing will further the success of high-speed reclosing to restore facilities to service in about 1/3 sec.

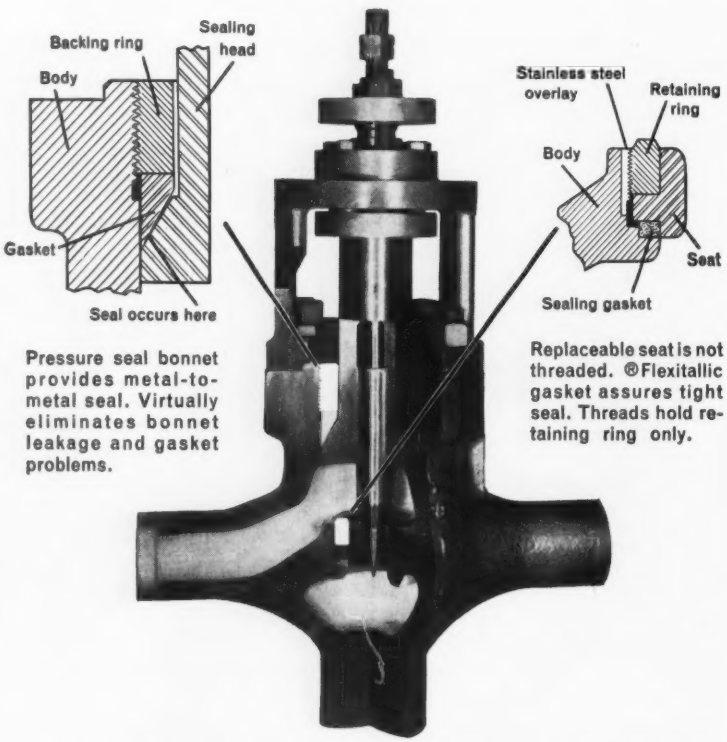
Lowest-cost desalting

Israel and the Fairbanks Whitney Corporation (owner of Fairbanks, Morse & Co) have developed a mass-production desalting machine. This is claimed to be the lowest-cost producer of fresh water yet developed. The first unit will be installed at Elath in Israel on the Gulf of Aqaba as part of a 4-unit plant with a total capacity of 250,000 gpd. Fairbanks, Morse will manufacture the desalting machinery in the U.S. and market it jointly with the nation of Israel. The Ministry of Development intends to build desalting machinery in Israel as soon as feasible. The mass-produced desalting unit uses a process invented by Dr Alexander Zarchin, an Israeli scientist.

U. S. Army Engineer R&D Labs at Fort Belvoir, Va. are testing a gas-turbine-powered tractor. A 5000-lb 200-hp diesel engine was replaced with a 600-lb 206-hp GM gas turbine. Adapting gearboxes offset weight differential.

ROCKWELL-REPUBLIC

High pressure globe valve withstands pressure drops up to body ratings



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Rockwell-Republic high pressure globe valves are available in 1½", 2", and 3" sizes for 1500, 2500 and 4500 psi standards. In addition to removable seat and pressure seal bonnet, these valves are available with bolted bonnets and quick-change trim. For more information about this and other Rockwell-Republic components and systems, just mail the coupon below. RF-23

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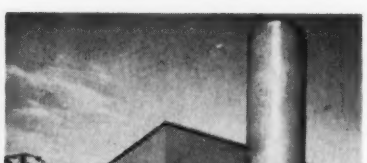
For more facts circle 299 on Reader Service card, p 101

Power Show includes sessions on two central stations

The 1961 American Power Conference, to be held March 21 to 23 at the Sherman Hotel in Chicago, will be comprised of 31 sessions. Most important will be devoted to design and operation of the Breed Station of the American Electric Power Company and the Avon Station of the Cleveland Electric Illuminating Company, two of the most advanced supercritical type stations.

Other sessions will include the future of nuclear energy and methods of generating power from nuclear fission. 100 papers will be given, covering electrical distribution and seawater conversion, among other subjects. Sponsored students and professors can tour Dresden Station.



Robot power station starts up in Britain

An unmanned "pocket" power plant operating under remote control by telephone from Electricity House in Bristol opened recently in Lynton, England. This is the second Bristol Siddeley 3-mw turbogenerator set to go into service anywhere in the world. The first, located at Princetown, has been in service almost a year.

Robot station is a modified version of the Bristol Siddeley Proteus turboprop aero-engine, power plant of the Britannia airliner. Producing 4250 hp, it's capable of supplying a town of 10,000 under emergency conditions. The lightweight plant was developed

Begins on page 152

to meet requirements of utilities, large industrials for peak-load operation, emergency supplies or for standby duty during maintenance. Unit can also be used as a mobile generator.

According to Bristol Siddeley, advantages of the equipment are its low capital cost, fully automatic operation with remote control and readiness at all times. Unit is compact, requires no outside water supply. Maintenance amounts to one visit per month.

Bristol Siddeley is now developing a 15-mw turbogenerator set using the Olympus jet engine, power plant of the RAF's Vulcan bombers, as prime mover. It will be installed at Hams Hall near Birmingham.

Shop-assembled carbon-monoxide-fired boiler goes to Uruguay

A 64-ton carbon-monoxide-fired boiler was recently lifted from a Wilmington, N. C. port to a vessel taking the package to its new home in Montevideo, Uruguay. There, the first carbon-monoxide-fired boiler in the southern hemisphere goes on stream shortly after arriving at a refinery extension of the Administración Nacional de Combustibles, Alcohol y Portland.

Unit, said to be world's first shop-assembled boiler fired by carbon monoxide, is designed for a pressure of 725 psi, for operating at a steam pressure of 600 psi, temperature of 750 F. During normal operation it generates 30,000-lb steam per hour while burning both oil and carbon monoxide—23,000-lb steam generated from the otherwise waste regenerator gases. When firing oil alone, the unit produces 43,000-lb steam per hour.

Station wrecked for the cause of science

London (*McGraw-Hill World News*) A power station constructed largely of concrete made with flyash has been scientifically wrecked. The Newman Spinney Experimental Station, Derby-

ROCKWELL-REPUBLIC

V-5 gauges combine small size with big-gauge readability

TRY THIS "CUTOUT TEST"

For a true demonstration of the readability of Rockwell-Republic V-5 gauges, cut out the actual-size photo at the right. Mount it on any wall or panel board. Step back and see how easily the scale can be read, even from 10 or 12 feet away!

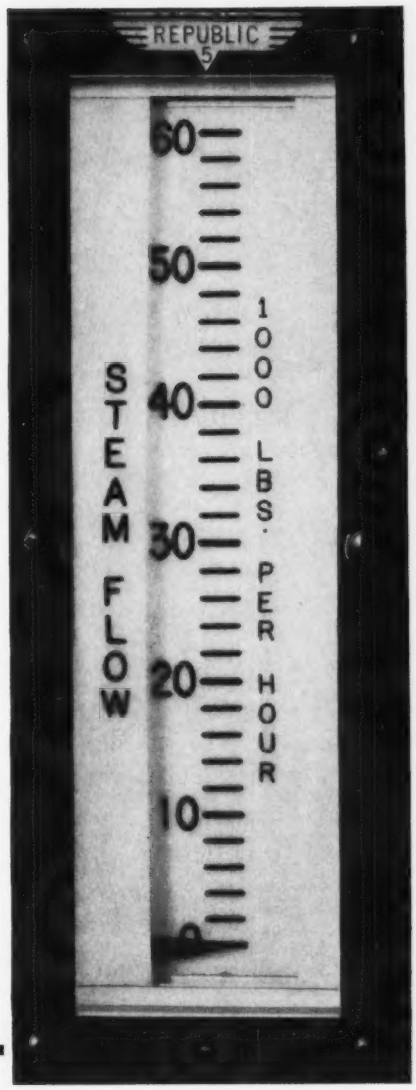
BIG-GAUGE ACCURACY, TOO

Compact V-5 gauges are equipped with electric receivers or full sized diaphragms, bellows, and helixes for maximum accuracy and sensitivity. Yet these Rockwell-Republic gauges require one-fourth the panel space needed for standard gauges.

GROUP MOUNTING INCREASES VERSATILITY

As many as eight gauges can be grouped in a single mounting case. Types can be mixed to meet individual panel requirements. Mounting is simple, too. Just a panel cutout is required in most cases.

There's a V-5 gauge for almost every process measurement. Mail the coupon today for the 12-page bulletin on these easy-to-read gauges, and for available literature on other Rockwell-Republic instruments, controls, and valves. RF-22



REPUBLIC INSTRUMENTS AND CONTROLS
more fine products by
ROCKWELL

Please send latest literature on the following:

☐ V-5 Gauges ☐ Process Transmitters ☐ Controllers
☐ Computing Relays ☐ Control Stations ☐ Recorders
☐ Flow Meters ☐ Drive Units ☐ Control Valves
☐ Desuperheating & Pressure Reducing Systems
☐ Electronic Control Systems ☐ Pneumatic Control Systems

Name_____ Title_____
Company_____
Address_____
City_____ Zone_____ State_____

Republic Flow Meters Co. *(Subsidiary of Rockwell Manufacturing Company)*
2240 Diversey Parkway, Chicago 47, Illinois

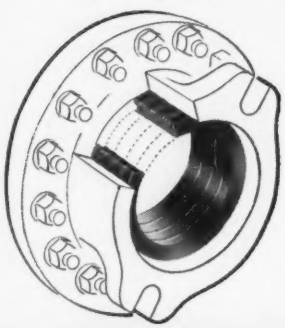
For more facts circle 300 on Reader Service card, p 101

HOW SEVENeering WITH R/M CUTS MAINTENANCE COSTS, PROTECTS RODS IN STEAM FORGING HAMMER APPLICATION

AVERAGE R/M PACKING LIFE 3 WEEKS, former packings only 1 week. And the R/M Vee-Square eliminated two packings because it is available in sizes to fit any hammer rod, stuffing box and packing gland. It's also uniform and easy to install.

43 hammers with R/M Vee-Square® Packings 15% savings in replacement packing costs

Here is a good example of SEVENeering with R/M. The Transue-Williams Steel Forging Corporation, Alliance, Ohio switched to R/M Vee-Square Packings for its 43 forging hammers at the recommendation of an R/M Distributor.* This move resulted in savings of 15%.



In addition, inventory was reduced — all makes of hammers in the plant now use R/M Vee-Square instead of three types. Pressure efficiency in the hammers is constant. A positive seal is maintained through stroke and return by R/M's Vee-Square, which combines the nonyielding properties of solid packing with the automatic sealing of V-ring design. Destructive and costly rod scoring is eliminated. Little gland adjustment is required, dry spots on the packing surface do not occur, and snug fit contributes to uniform rod wear.

Transue-Williams is but one of thousands of plants SEVENeering with R/M to solve their packing problems. Our Big 7 Packing Selection Chart is a helpful guide to the selection and application of R/M Packings for all types of equipment. Write for your copy today. See your authorized R/M distributor for immediate requirements now. He will make suggestions, and supply the packings you need — usually from stock.

*The Alan Packing & Rubber Co., Cleveland, Ohio

R/M's Big 7 Packing Types meet 95% of all packing needs, are sold exclusively through authorized R/M distributors

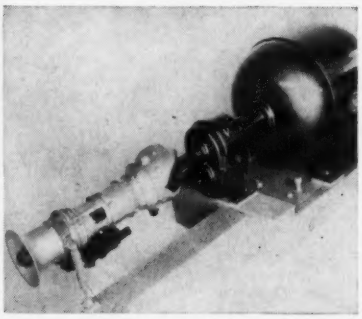
RAYBESTOS-MANHATTAN, INC.
BIG 7 PACKINGS
PACKING DIVISION, PASSAIC, N.J.
MECHANICAL PACKINGS AND GASKET MATERIALS

Powerscope

Begins on page 152

shire, England, was built to determine the strength of concrete made with this energy-system waste product and was wrecked after only six weeks' operation.

After it was stripped of its boilers and generating equipment, hydraulic jacks exerting many tons of pressure were applied to each main beam in the generator house. Each test took two or three days. Newman Spinney Station was a thing of the past at the end of February.



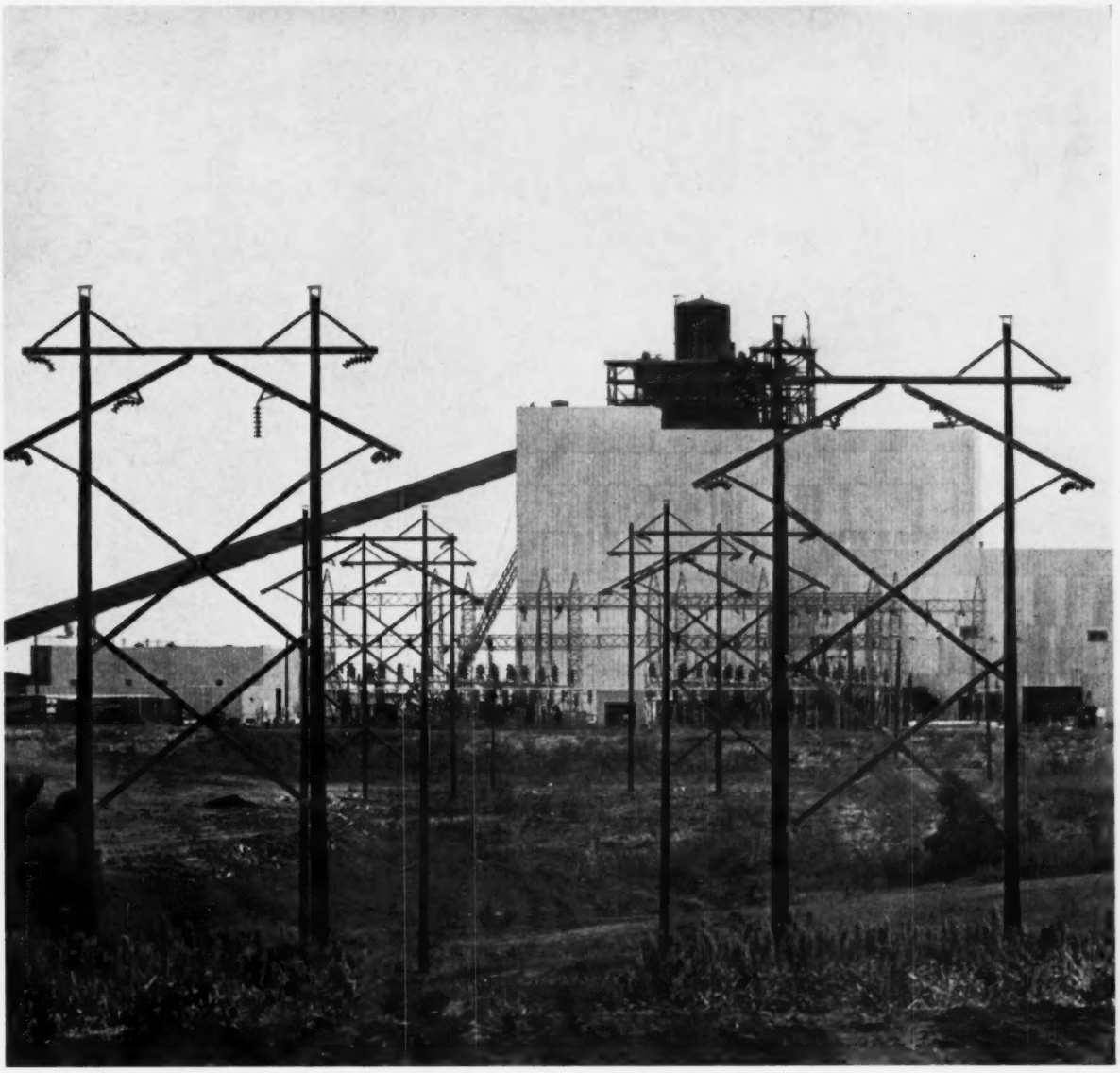
Rooftop plant can power phones for 70,000

A 750-kw standby power plant installed on Pacific Telephone & Telegraph Co's roof will give dependable supplementary power for emergency operation of the entire downtown facility, say officials of the Oakland utility. General Electric gas-turbine-generator unit above has model 720 industrial turbine, left, reduction gearing and 4160-v ac synchronous motor, right. Entire plant weighs 12,235 lb—70% less than conventional units.

The 320-lb gas turbine delivers more than three hp per lb of its weight. It's the same unit that's being used to power experimental hydrofoil boats, amphibious vehicles and pipeline pumping stations. Other components: engine control panels, switchgear and base.

Speed-reducing gear cuts engine's 19,500 rpm to 1200 for generator operation. Flexible couplings isolate engine from gear and gear from generator load. One engine control panel

75,000 KW Sodium Graphite Reactor station for Consumers Public Power District at Hallam, Nebraska



The Peaceful Atom

Helping the world double its power supply in the next ten years

The fuel of the future is in the atom. But even now, lights are burning, wheels are turning, thanks to atomic fuel. Atomics International, a world-wide leader in advanced, high-performance reactor systems, has over 15 years' experience in designing, constructing, and operating reactors. Two of the world's most advanced atomic power stations are now being built by AI under AEC programs. The wealth of experience and facilities at Atomics International will help the world's power-producing companies in their plans to double the supply of electricity in the next ten years.

ATOMICS INTERNATIONAL

Division of North American Aviation

Pioneers in the creative use of the atom

World Headquarters: Canoga Park, California, U.S.A. Cable Address: ATOMICS. *Other offices:* Washington, D.C., U.S.A.; Geneva, Switzerland. *Affiliated with:* INTERATOM, Bensberg/Cologne, Federal Republic of Germany and DYNATOM, Paris, France

Compressed Air Data You should have about damage caused by Water, Vapors, Acid fumes and Abrasives in the Air System

A study and discussion of compressed air and its inherent properties which cause corrosion, contamination, abrasion and freezing of pneumatic equipment are covered in 16-page brochure "*Moisture Control.*"

Now in its 26th printing, the brochure explains how the unique, low-cost Van-Air method extracts water. vapors, acid fumes and abrasives which normally flow past aftercooler and receiver—how these elements corrode pneumatic equipment and controls—damage products in process—contaminate exposed solutions.

The method (which operates for *less than ONE-CENT per 18,000 cu. ft.*) requires no heat or power—no regeneration—delivers air dry, clean, sterile and non-toxic. Now used in hundreds of different applications in all types of plants—large and small. The method can treat any volume of compressor output from minimal air for smallest instrument, gage, tool, etc. to total air for entire plant. It has no capacity limit. Ask for brochure—*free on request.*

VAN PRODUCTS CO.• MFRS.

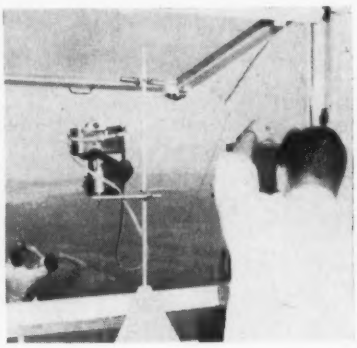
5776 SWANVILLE ROAD, ERIE, PA.

circle 303 on Reader Service card, p 101

Powerscope

Begins on page 152

is at the unit and another is at a master control center for remote operation. Supported by steel subbase, power package is completed by free-standing switchgear cubicle, battery and heat exchangers.



Lightning study on mountain top

Lightning that hits the trailer atop Dunning Mountain in western Pennsylvania will be recorded as two electrical engineers spend their summers attempting to learn about its effects on EHV transmission lines. Oscillographs and cameras are connected to a 13-mi 460-kv transmission line not far away.

In an area where electrical storms occur 38 to 40 days each summer, Steve J Polaski of Pennsylvania Electric Company and Donald J Heller of General Electric will have ample opportunity to record the number of strikes that hit the line, electric-field intensities, lightning-wave shapes and amplitudes and resulting line voltages. A still camera will photograph the location of strikes and a high-speed camera will record stages of the lightning strokes.

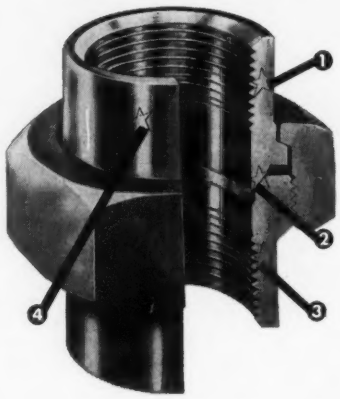
Both men and equipment underwent testing at GE. Heller was inside the well-protected trailer when 40,000 amp of man-made lightning were used. Ground wires and lightning rods on the line are mounted on insulators and connected to the ground via pick-up coils and shunts.

Findings will help utility engineers test reliability of an EHV line.

continued

only CATAWISSA

gives you all these features for your forged steel pipe union requirements



1. **Uniform walls** for even expansion and contraction under temperature changes. They follow the pipe!

2. **Catawissa Ball-to-Angle Seats** give you a "Perfect Seal" regardless of pipe alignment!

3. **More than adequate** wall thicknesses give you Catawissa's 3-to-1 Safety Factor (3000-lb. service, 9000-lb. test; 6000-lb. service, 18000-lb. test)!

4. **Round, straight barrels** for fast wrenching. No uneven or tapered surfaces to cause wrench slips or wrench locking!

Catawissa Perfect Seal Pipe Unions are made by Union Specialists from 80,000 lb. tensile strength steel (ASTM Spec. A-105-55T, Grade II). Steel forgings from our own forging mill are closely checked for imperfections . . . and finishing on modern, automatic machines with close inspection during and after production give you pipe unions second to none!

Write for Catalog 60 showing the complete Catawissa line of Perfect Seal Products.

for complete, guaranteed satisfaction

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CATAWISSA

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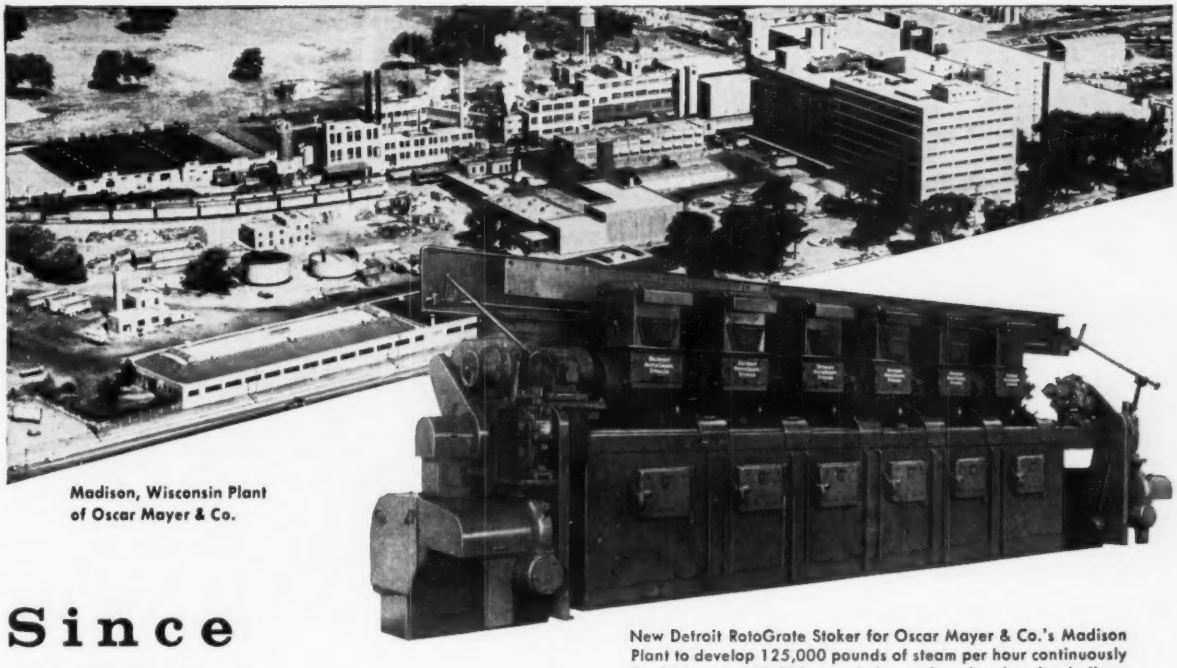


Madison, Wisconsin Plant
of Oscar Mayer & Co.

New Detroit RotoGrate Stoker for Oscar Mayer & Co.'s Madison Plant to develop 125,000 pounds of steam per hour continuously for 24 hours—150,000 pounds for peaks, when burning Indiana coal, 10530 BTU per pound, 13.25% ash, A. F. T. 1900° F. Helmick and Lutz, Minneapolis, Consulting Engineers.

Since 1938

Detroit Stokers have served Famous Sausage Makers with Economy . . . High Availability . . . Low Maintenance

Oscar Mayer & Co., pioneer meat processing firm, has been making sausages since 1883. By stressing quality and uniformity of product, it has grown from a small meat market on the near-north side of Chicago to the nation's 9th largest producer with sales last year of $260,000,000.

In 1938, the company installed a Detroit RotoStoker in the Madison, Wisconsin, plant. Purchase of a plant in Davenport, Iowa, brought them another RotoStoker in 1941.

These served so well that in 1947, they bought a Detroit RotoGrate Stoker for the Madison plant as a part of an expansion program.

When more expansion was planned in 1959, they bought two more RotoGrates, one each for the Madison and Davenport plants, making a total of five acquired since 1938.

Detroit RotoGrate is an overthrow spreader stoker with traveling grates that move slowly forward, discharging ash at the front. Suitable for boilers up to 400,000 pounds of steam per hour capacity . . . it burns any bituminous coal or lignite and many types of refuse, separately or in combination with coal. It is one of the complete line of Detroit Stokers for small, medium and large boilers.

DETROIT STOKERS
COST LESS

DETROIT
SINCE 1898
STOKERS

Cost equals initial investment plus upkeep, plus production losses due to equipment outage. *The total is less with Detroit.*

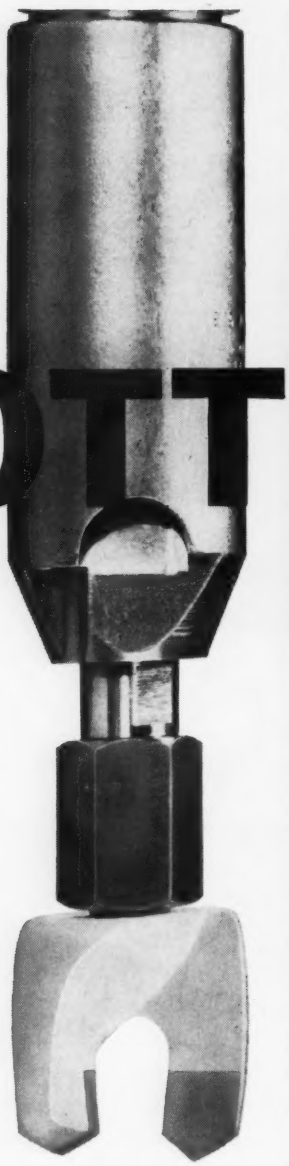
DETROIT STOKER COMPANY
DIVISION OF UNITED INDUSTRIAL CORPORATION
MAIN OFFICE AND WORKS • MONROE, MICHIGAN
District Offices or Representatives in Principal Cities

For more facts circle 305 on Reader Service card, p 101

to clean badly clogged air preheater tubes

ELLIOTT

heavy duty tube cleaner



Shown above is the powerful Lagonda heavy-duty air motor with carbide-tipped cutter bit. Attached to a flexible air hose, this unit can operate in any position where headroom is limited. The carbide tip will clean even the most badly clogged tubes, quickly and effectively.

Where headroom permits, the heavy-duty suspended-type motor shown at the right can be used to drive a cutting bit attached to a hollow steel shaft, through which flushing and cooling water is fed. This extremely powerful unit can be used either vertically or horizontally.

Full information and prices may be obtained from any Elliott District Sales Office, or by writing Elliott Company, Lagonda Plant, Springfield, Ohio.

V 1-1

ELLIOTT COMPANY

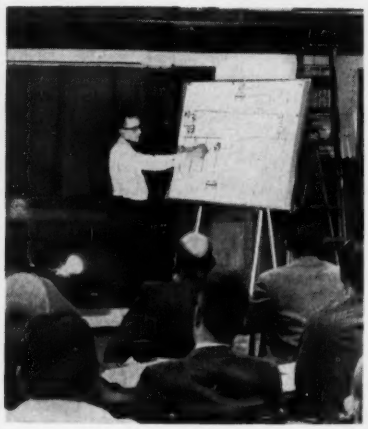
GENERAL OFFICES: JEANNETTE, PENNSYLVANIA

PLANTS AT: Jeannette and Ridgway, Pa.; Springfield, Ohio

TURBINES • GENERATORS • MOTORS • COMPRESSORS • TURBOCHARGERS
DEAERATING HEATERS • EJECTORS • CONDENSERS • STRAINERS • TUBE CLEANERS

Powerscope

Begins on page 152



IEC offers industrial-power-distribution course kit

An industrial-power-distribution course is on sale to electric utilities to train plant personnel in selecting electrical systems and components. Released by the Industrial Electrification Council, kit consists of ten 2½-hr demonstration lectures. Lectures start with basic fundamentals of a simple circuit and go on to voltage selection and regulation, power-factor improvement, protective and control devices, preventive maintenance, system planning and grounding.

Working-model fuel cell: aid to education

A fuel-cell demonstrator kit which turns chemical energy directly into electrical energy is available from Allis-Chalmers Mfg Company for instructional purposes. Kit contains a fuel cell (housing and electrode plates) and small electric motor, plus leads.

Fuel used is alcohol, oxidant is hydrogen peroxide and the electrolyte is potassium or sodium hydroxide. Catalysts are platinum for the fuel and silver for the oxidant. The combined ingredients react with the catalyzed electrode surface to produce current flow which drives the motor. Price: $9.75.

continued

When it's time for replacement . . .

. . . more and more plants switch to OIC valves!

There's no magic to it! Engineers responsible for power and production look to OIC for longer continuous service and lower maintenance costs. These men have found by experience OIC iron and bronze valves (cast and forged steel and ductile iron too) are built to resist the three enemies of fluid handling . . . erosion, galling and corrosion. Trim variations are available to meet your specific requirements including special alloys for highly corrosive and severe pressure-temperature operating conditions.

OIC offers a complete line of gates, globes, angles and checks. Large stocks are carried throughout the United States by a fine distributor organization which stands ready to help you with all your valve problems. Our engineers are ready at a moment's notice to study particularly tough problems and submit recommendations. Get acquainted with your OIC distributor and learn how he can help you cut maintenance and replacement costs.

Better valves and better service from OIC distributors

INDUSTRIAL DISTRIBUTORS — SERVING INDUSTRY ECONOMICALLY — THE RIGHT HAND OF PRODUCTION

OIC VALVES

BRONZE, IRON, FORGED STEEL, CAST STEEL AND DUCTILE IRON VALVES

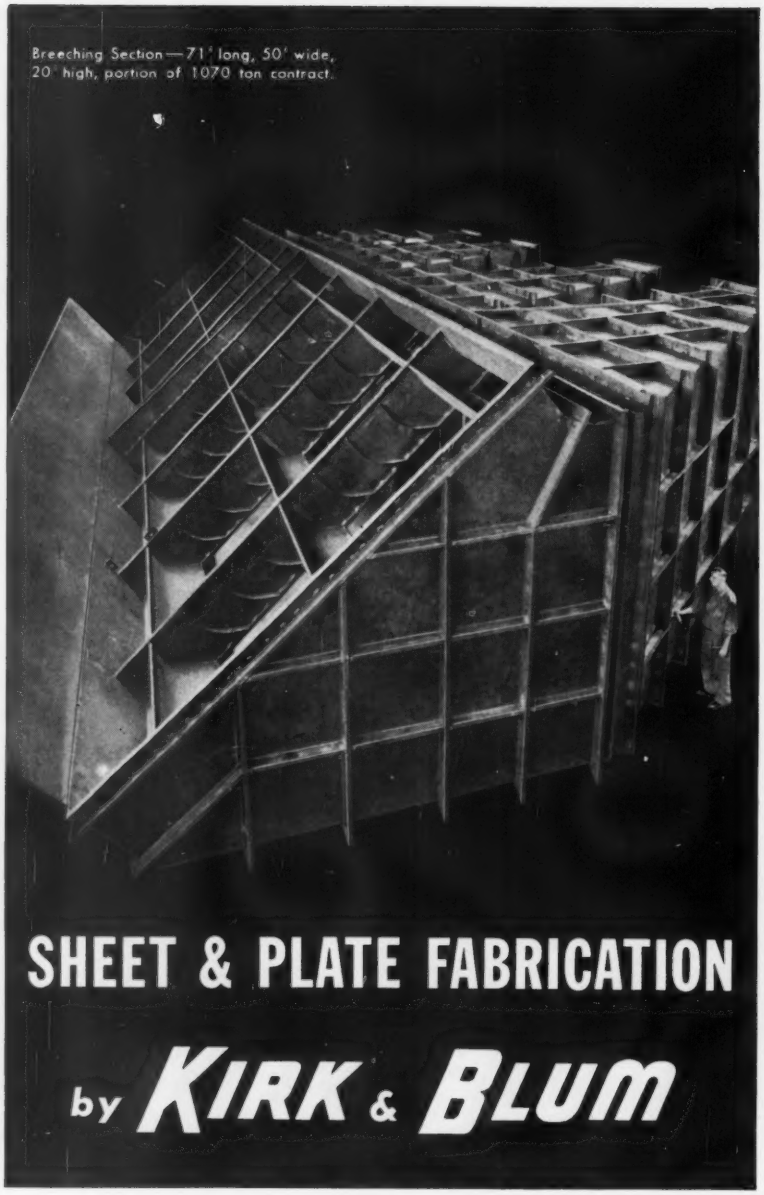
10230-OIC

THE OHIO INJECTOR COMPANY
251 Main Street, Wadsworth, Ohio

Please send more information about Iron ( ) Bronze ( ) Steel ( ) Ductile Iron ( ) Valves.

Name_____
Company_____
Street_____
City_____ Zone_____ State_____

For more facts circle 307 on Reader Service card, p 101



Why can Kirk & Blum save you time and money on huge fabrications? Extensive facilities and equipment of a 170,000 sq. ft. plant enable experienced K & B craftsmen to utilize their production ingenuity to the fullest.

Heavy assemblies, up to ½" thickness are produced, pre-assembled and loaded for shipping in a 50' x 480' bay with overhead handling capacity up to 25 tons.

Send prints for prompt quotation or write for your copy of new K&B Sheet and Plate Fabrication Catalog.

THE KIRK & BLUM MANUFACTURING CO. 3233 FORRER STREET, CINCINNATI 9, OHIO

BREECHINGS • STACKS • AIR & GAS DUCTS • CASINGS • LOUVERS • TANKS
BINS • HOPPERS • INSULATION JACKETING • CONTROL PANELS & DESKS

Powerscope

Begins on page 152

Pure water out— clean water in

The people of Middletown, Ohio, by building and paying for a $1-million sewage-treatment plant and $7-million in sewers, made sure the water they drank from the Miami River was pure. Residents of South Charleston, W. Va. joined forces with the Union Carbide Chemicals Company to lick separate pollution problems. They are building a municipal-industrial-waste water-treatment plant to be designed and operated by Union Carbide.

This is an example of attempts to undo damage caused by raw sewage and industrial waste indiscriminately dumped into rivers without thought of the people who must drink the water. In Middletown, both industry and communities that use clean water feel the responsibility to return clean water to the rivers.

Waste incinerator makes steam for industry

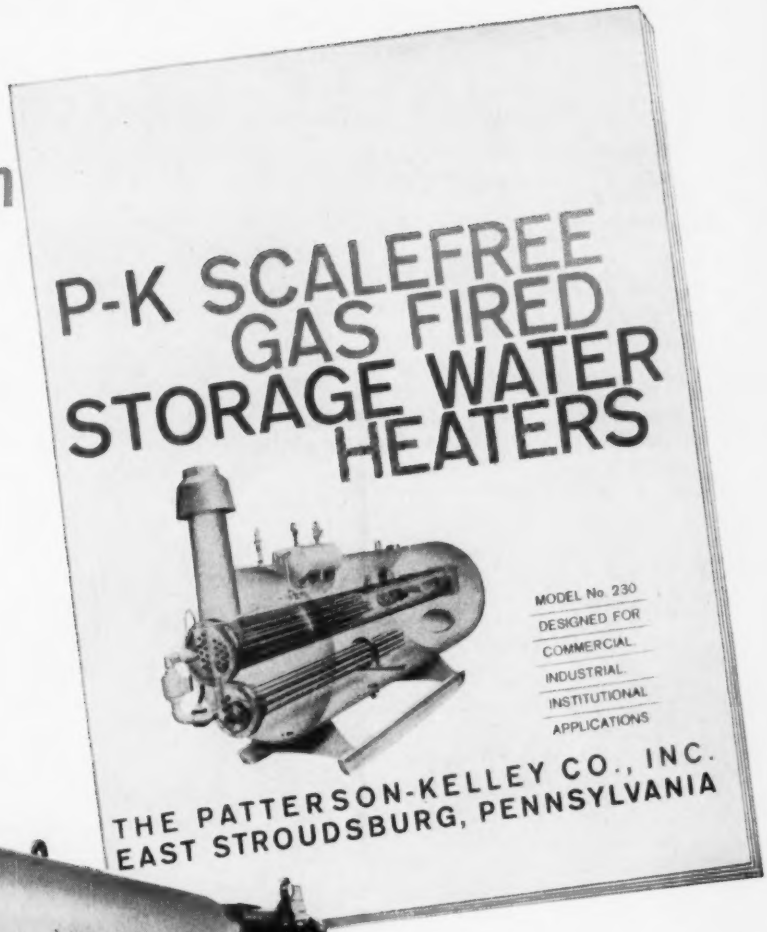
Buffalo N. Y. (*McGraw-Hill World News*) A possible new source of revenue for the city of Buffalo: selling steam from salvaged waste-incinerator heat to industry. Buffalo's mayor has initiated study of the project using Chicago's waste-heat program as an example.

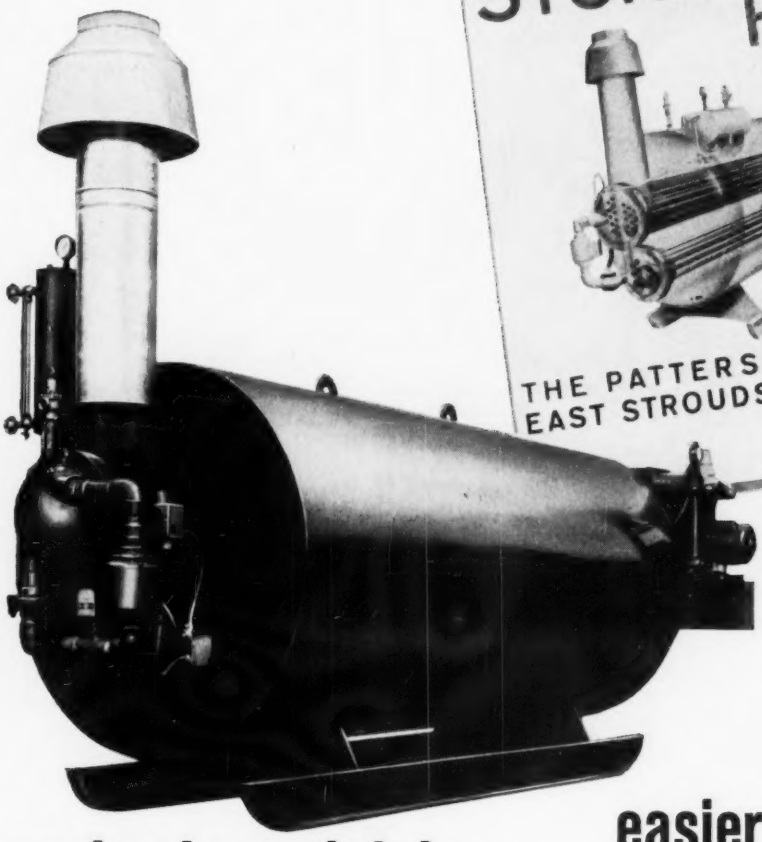
Chicago plans to build a new incineration plant with four 300-ton rotary-kiln furnaces. This will be the city's third incinerator. Four 50,000-lb-per-hr boilers will use waste gases from the plant to generate steam for a Chicago industrial. Expected steam sale: 600,000,000 lb per year for an annual profit of $100,000.

Buffalo is considering a similar steam-generating plant in the city's proposed incinerator. Steam from Buffalo's plant would go to industry, or possibly to heat a municipal-service building and garage—either one saving the city money.

Japan's biggest underground plant, the Kurobe Power Plant, will have a combined output from four generators of 258,000 kw when it goes into operation after 1963.

send for bulletin no. 4





easier to maintain ... easier to install ...

Striking new economies are now available for commercial, industrial and institutional buildings with P-K's SCALEFREE 230, the first indirect gas fired storage water heater • **Installation.** A complete and automatic package, P-K's SCALEFREE 230 can be skidded into place, hooked up and checked out quickly. There is no complicated piping or electrical work to run up costs. No stack is needed for extra draft. No foundation is necessary. Factory insulation (optional, as illustrated) further reduces costs and avoids the complications of on-the-site insulating. • **Maintenance.** P-K's SCALEFREE 230 offers new freedom from trouble. It won't scale—and retains its rated efficiency—because heat transfer occurs below the temperature at which scaling minerals precipitate. Linings of Pre-Krete® or copper keep the storage section free of rust and corrosion regardless of water conditions. • P-K's SCALEFREE 230 is available in storage capacities from 250 to 4,000 gallons; recovery sections from 390,000 to 2,215,000 BTU. Bulletin No. 4 gives complete engineering and performance data.

Address your request to: The Patterson Kelley Co., Inc., 83 Morgan Avenue, East Stroudsburg, Pennsylvania.

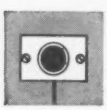
Patterson Kelley
Water Heater Division

For more facts circle 309 on Reader Service card, p 101

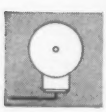
McDONNELL *Flow Switches*

Here's what they do!

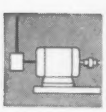
What you see here is a compact, well-built switch that makes or breaks a circuit (as required) when liquid flows or stops flowing. It's an economical and positive way to start or stop anything electrically operated. Just to highlight a few uses:



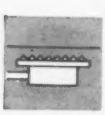
to actuate a signal light—signal an attendant to make the right moves in operating valves, pumps and the like—signal him when flow stops in a water cooled compressor, water cooled bearing and so on.



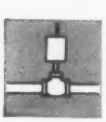
to sound an alarm—when flow stops in a process system or in any water cooled devices.



to start or stop motors—start pumps in sequence in multiple stage flow systems; start standby pumps; stop automatically controlled units if cooling water system fails; stop compressors in cooling systems when flow stops.

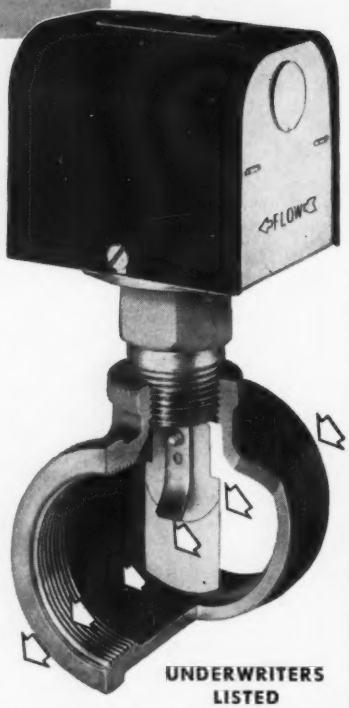


to start or stop automatic burners—start a booster heater when water draw occurs, stop burner if flow is improperly retarded; make sure of circulation in a boiler before burner is permitted to start.



to actuate metering device—open valve in chemical feeder line; start mixing in secondary line whenever flow starts in primary line.

FS4 Series Flow Switch shown mounted in a 2 inch Tee



UNDERWRITERS LISTED

Positive snap action switch. Easy to install and wire. Segmented paddle fits any pipe from 1" through 3". Unit shown handles pressures to 100 psi, temperatures to 300° F., in these types:

FS4-3—SPDT switch. Opens and closes two separate circuits with flow; closes and opens same two circuits with no flow.

FS4—Closes with flow; opens with no flow.

FS4R—Opens with flow; closes with no flow.

NOTE: Model E-2 available for larger pipes, pressures to 150 psi.

McDONNELL & MILLER, *Inc.*
3506 N. Spaulding Ave., Chicago 18, Ill.

Doing One Thing Well

Coupon brings bulletin

—covering design, construction, electrical ratings, dimensions, typical applications.

Please send me a copy of Flow Switch Bulletin FS1-A.

Company_____

Address_____

City, Zone, State_____

By_____

Mail to: McDonnell & Miller, Inc., 3506 N. Spaulding Ave., Chicago 18, Ill.

Calendar

March 12-17—American Society of Mechanical Engineers, Boiler and Pressure Vessel Committee joint meeting with National Board of Boiler and Pressure Vessel Inspectors. Barringer Hotel, Charlotte, N. C. Details: ASME, 29 W 39th St, New York 18, N. Y.

March 13-17—National Association of Corrosion Engineers, 17th Annual Conference and Show, Hotel Statler, Buffalo, N. Y. Details: T J Hull, 1061 M&M Building, Houston 2, Texas.

March 20-24—American Society for Metals, Western Metal Show, Pan Pacific Auditorium, Los Angeles, Calif. Details: J C Nelson, Metals Park, Novelty, Ohio.

March 21-23—American Society of Mechanical Engineers, American Power Conference, Sherman Hotel, Chicago, Ill. Details: ASME Meetings Dept, 29 W 39th St, New York 18, N. Y.

March 21-30—American Chemical Society, National Meeting, St. Louis, Mo. Details: R Avery, American Chemical Society, 2 Park Ave, New York 16, N. Y.

March 27-31 — National Symposium on Temperature—its Measurement and Control in Science and Industry, sponsored by American Institute of Physics, ISA, and National Bureau of Standards, Veteran's Memorial Hall, Deshler-Hilton Hotel, Columbus, Ohio. Details: W R Tilley, NBS, Washington, D.C.

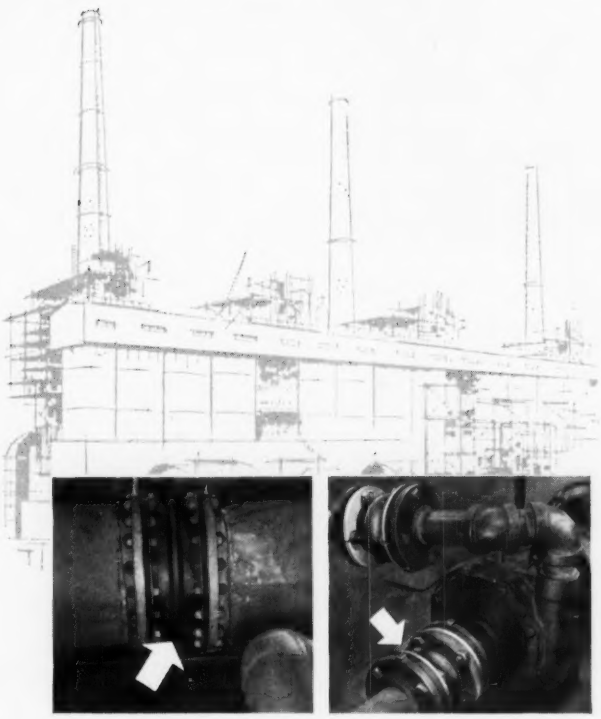
April 6-7—American Society of Mechanical Engineers. Management Engineering Conference, Statler-Hilton Hotel, New York, N. Y. Details: ASME Meetings Dept, 29 W 39th St, New York 18, N. Y.

April 9-13 — American Society of Mechanical Engineers, Oil & Gas Power Conference & Exhibit, Jung Hotel, New Orleans, La. Details: ASME Meetings Dept, 29 W 39th St, New York 18, N. Y.

continued

ENGINEERED PRODUCTS

for Plant Maintenance



Typical installations show Garlock Rubber Expansion Joints on a 26" vacuum condenser inlet (left) and 2½" suction and discharge pipes. Garlock furnishes standard joints from ¾" to 72" in pipe diameter, and in all shapes.

Install Garlock Rubber Expansion Joints. It's good piping practice; here is why:

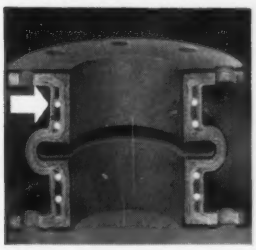
1. Prevent stresses. Piping systems expand and contract with temperature changes. Garlock Expansion Joints act as a "breather" . . . compensate for expansion and contraction.

2. Eliminate vibration and noise. Pumps, compressors, engines, and pressure surges in pipe lines create vibration and objectionable noises. Garlock Rubber Expansion Joints act as an absorbent cushion . . . reduce vibration and insulate against transfer of noise to other parts of the building.

3. Compensate for misalignment. Piping and mechanical equipment often move out of normal alignment during operation due to wear, load, stresses, or settling of buildings. Garlock Rubber Expansion Joints compensate for this and prevent possible breakdowns of equipment. They also make installation easier since alignment of piping and equipment need not be as accurate when expansion joints are used.

4. Reduce flange breakage. Undue stress caused by misalignment, vibration, expansion or contraction of piping or equipment, will break the metal connecting flanges. Garlock Rubber Expansion Joints relieve such stresses.

Offer many application advantages. Garlock Rubber Expansion Joints outlive metal ones; do not crack, corrode, lose shape, or require gaskets. The sturdy construction of Garlock Rubber Expansion Joints results in satisfactory service where pressures are as high as 150 p.s.i., temperatures to 180°F.



Expansion joints are also available for service up to 450°F. In the photo of the joint cut in half, the arrow points to a steel reinforcing ring which, when varied in number with the joint size, provides the extra strength needed for the most severe applications.

For more data, call the nearest of the 26 Garlock sales offices and warehouses throughout the U.S. and Canada. Or, write for Catalog AD-137, Garlock Inc., Palmyra, N.Y.

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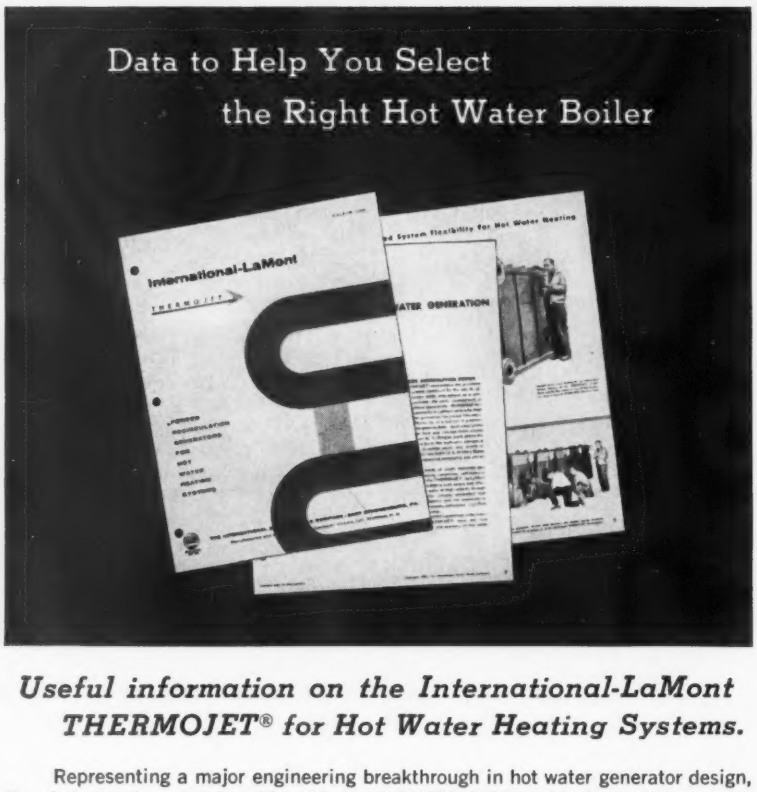
For more facts circle 311 on Reader Service card, p 101



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Calendar

April 10-11 — American Society of Mechanical Engineers, Maintenance & Plant Engineering Conference, Bancroft Hotel, Worcester, Mass. Details: ASME Meetings Dept, 29 W 39th St, New York 18, N. Y.

April 10-12—American Institute of Mining, Metallurgical and Petroleum Engineers, Open Hearth & Blast Furnace Conference, Sheraton Hotel, Philadelphia, Pa. Details: AIME, 29 W 39th St, New York 18, N. Y.

April 10-21—American Welding Society, 42nd Annual Convention and Welding Exposition, Sheraton-Atlantic Hotel, Coliseum, New York, N. Y. Details: Information Center, AWS, 33 W 39th St, New York 18, N. Y.

April 17-19—Instrument Society of America, 7th National Symposium on Instrumental Methods of Analysis, Shamrock-Hilton Hotel, Houston, Texas. Details: ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

April 23-26—American Society of Mechanical Engineers, Metals Engineering Conference, Penn Sheraton Hotel, Pittsburgh, Pa. Details: ASME Meetings Dept, 29 W 39th St, New York 18, N. Y.

April 23-26—Oil Heat Institute of America, Inc, 39th Annual Meeting, Statler-Hilton Hotel, Washington, D.C. Details: OHI, 500 Fifth Ave, New York 36, N.Y.

April 26-27 — Metallurgical Society of AIME, National Technical Conference On H-T Materials, Pick-Carter Hotel, Cleveland, Ohio. Details: Metallurgical Society of AIME, 29 W 39th St, New York 18, N. Y.

April 30-May 3 — Electrochemical Society, Meeting, Claypool Hotel, Indianapolis, Ind. Details: Electrochemical Society, 1860 Broadway, New York 23, N. Y.

May 1-3 — Electric Association, Lighting Exposition, Lake Front Exposition Hall, Chicago, Ill. Details: Electric Association, 140 S Dearborn St, Chicago 3, Ill.

Begins on page 164

May 8-9 — American Society of Mechanical Engineers, Lubrication Symposium, Deauville Hotel, Miami Beach, Fla. Details: ASME Meetings Dept, 29 W 39th St, New York 18, N. Y.

May 7-10 — American Institute of Chemical Engineers, Meeting, Sheraton-Cleveland Hotel, Cleveland, Ohio. Details: AIChE, 25 W 45th St, New York 36, N. Y.

May 7-11—American Society of Mechanical Engineers, Hydraulic Conference, Queen Elizabeth Hotel, Montreal, P.Q., Can. Details: ASME Meetings Dept, 29 W 39th St, New York 18, N. Y.

May 8-10 — Instrument Society of America, 4th National Power Instrumentation Symposium, LaSalle Hotel, Chicago, Ill. Details: Meetings Manager, ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

May 9-11—Annual Western Joint Computer Conference, National Joint Computer Committee—Institute of Radio Engineers, American Institute of Electrical Engineers, Association for Computing Machinery, Ambassador Hotel, Los Angeles, Calif. Details: Dr W F Bauer, Thompson Ramo Wooldridge, Inc, Ramo-Wooldridge Div, 8433 Fallbrook Ave, Canoga Park, Calif.

May 10-12—Pulp and Paper Instrumentation Symposium, sponsored by ISA, TAPPI, Northland Hotel, Green Bay, Wis. Details: Meetings Services Dept, ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

May 22-24—10th National Telemetering Conference, sponsored by ISA, AIEE, ARS, IAS, IRE, Sheraton-Towers Hotel, Chicago, Ill. Details: Meetings Services Dept, ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

May 22-25 — American Society of Mechanical Engineers, Design Engineering Conference & Show, Cobo Hall Hotel, Detroit, Mich. Details: ASME Meetings Dept, 29 W 39th St, New York 18, N. Y.

continued

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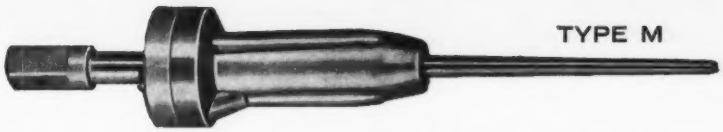
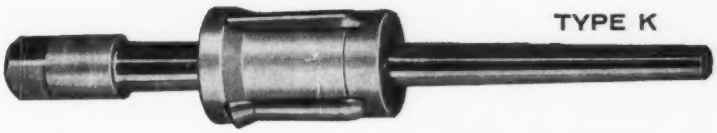
for tubes 3/4 in. I.D. and up





This 16-page bulletin describes general types of Elliott boiler tube expanders for fast, efficient tube rolling jobs. It also gives dimensions, prices and other descriptive data and shows various drum, header and short series mandrels which are used with Elliott boiler tube expanders. Drum mandrels are seen with Type M and Type K above.

Accessories available to adapt Elliott boiler tube expanders to various tube rolling applications include universal joints and extension shafts, sockets, gear drives, etc. A new heavy-duty, right-angle gear drive utilizes roller bearings to minimize friction, cutting down power losses.

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Y7-8

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For more facts circle 313 on Reader Service card, p 101

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Williams-Hager **Silent CHECK VALVES**

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For more facts circle 314 on Reader Service card, p 101

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circle 315 on Reader Service card, p 101

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Calendar

Begins on page 164

June 6-8—Instrument Society of America, Summer Instrument-Automation Conference and Exhibit, Royal York Hotel, Queen Elizabeth Hall, Toronto, Ont., Can. Details: W H Kushnick, ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

June 11-15 — American Society of Mechanical Engineers, Summer Annual Meeting, Statler-Hilton Hotel, Los Angeles, Calif. Details: ASME Meetings Dept, 29 W 39th St, New York 18, N. Y.

June 12 — Air Pollution Instrumentation Symposium, ISA, APCA sponsoring, Hotel Commodore, New York, N. Y. Details: Meetings Manager, ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

June 12-15 — National District Heating Association, 52nd Annual Meeting, Wentworth - by - the - Sea, Portsmouth, N. H. Details: J F Collins Jr, NDHA, 827 N Euclid Ave, Pittsburgh 6, Pa.

June 14-16—Applied Mechanics Conference, Ill. Inst of Technology, Chicago, Ill. Details: ASME Meetings Dept, 29 W 39th St, New York 18, N. Y.

June 28-30 — 2nd Joint Automatic Control Conference, sponsored by ISA, AIChE, AIEE, ASME, IRE, U of Colorado, Boulder, Colo. Details: Meetings Manager, ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

July 18-20 — Western Plant Maintenance & Engineering Show & Conference, Pan Pacific Auditorium, Los Angeles, Calif. Details: Clapp & Poliak, Inc, 341 Madison Ave, New York 17, N. Y.

Sept 11-15—Instrument Society of America, Fall Instrument-Automation Conference & Exhibit, 16th Annual Meeting, Memorial Sports Arena, Los Angeles, Calif. Details: W H Kushnick, ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

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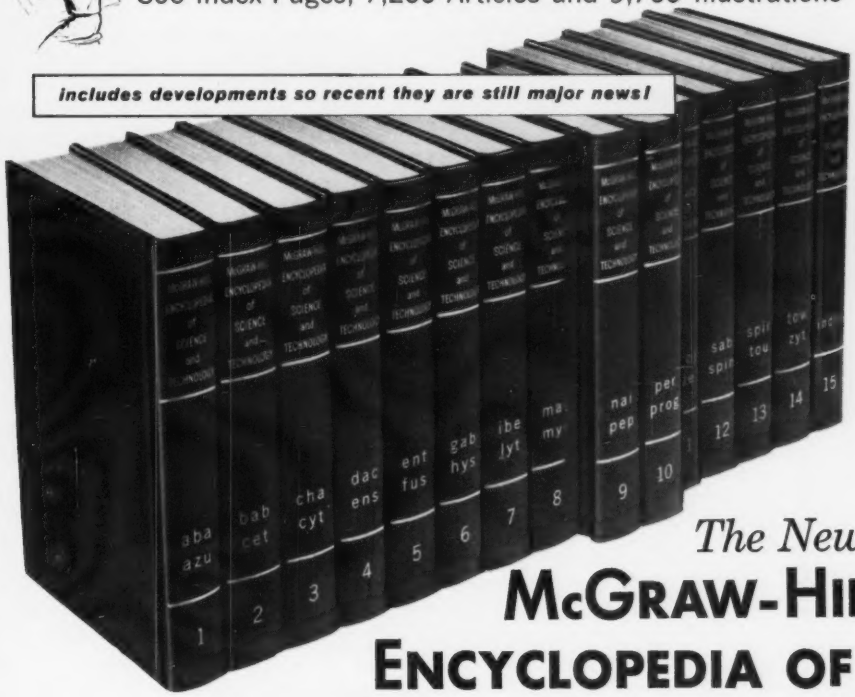

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P-3

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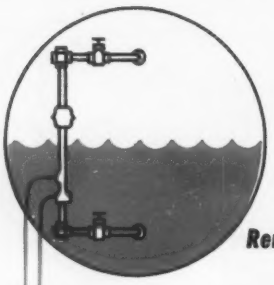

Remote indication saves time—increases safety

Any water-containing vessel is a potential hazard, whether it's fired or unfired. For most efficient control, *gages for all vessels should be out in the open, or at control stations.*

Where remote reading gages should be used:

Stationary power boilers
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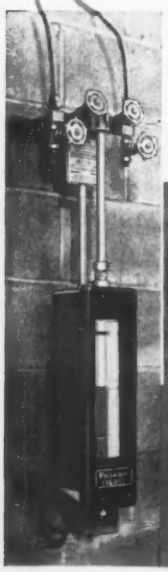
Waste heat boilers
Surge tanks
Water treatment systems
Heating boilers
Storage tanks
Marine power boilers

What you should expect in a remote reading water level indicator	Reliance EYE-HYE
Flexibility of placement. Gage reading precisely where most convenient to use — even above the boiler.	✓
Sharp visibility. Easy to read green indicating fluid, illuminated.	✓
Scientific accuracy. U tube manometer principle for laboratory exactness.	✓
Simplicity. Smooth hydrostatic action — no mechanical working parts.	✓
Safety. Invites frequent reading — an aid to preventing water level accidents.	✓
Easy installation. Flexible tubes from boiler to gage window.	✓
Low maintenance. Scheduled cleaning only at infrequent intervals. Easy to blow down.	✓



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Appointments

Awards

American Standards Association awarded two gold medals, their highest awards in the field of national standards work, to J H Foote, vice-president of Commonwealth Services Inc and R C Sogge, retired manager of the Standards Div of General Electric Company. Foote's award, The Howard Coonley Medal, is given each year to an executive helping to advance the national economy through voluntary standards. In improving electrical-industry standards through his engineering work, Foote encouraged other industry representatives to recognize the importance of standardization, the association said.

The Standards Medal given to Sogge is annually awarded to an individual serving the voluntary-standards movement by leading in the actual development of standards. Sogge was vice-president of the International Electrotechnical Commission (IEC) and president of the U.S. National Committee of IEC from 1953 to 1959. He served on many industry and professional committees, has worked on 15 boards and committees of the American Standards Association.

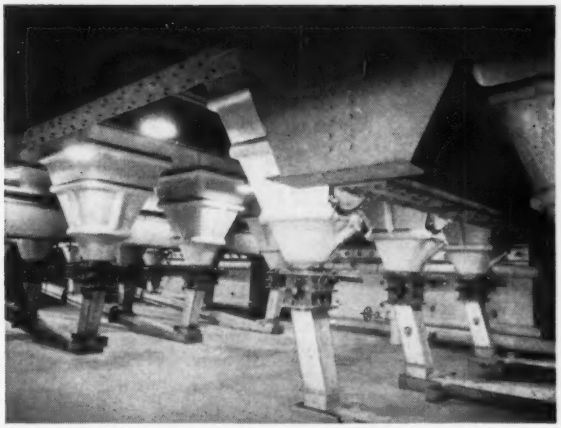
Management changes

The Babcock & Wilcox Co: A P Taber, vice-president in charge of Research and Development Div. **Borg-Warner Corp:** F W Rickard, W F Martin, Dr D W Collier, vice-presidents. **Boston Edison Co:** C F Avila, president. **Catawissa Valve & Fittings Co:** C L Davis, president.

Computer Systems, Inc: W A Ogletree, general manager. **Euclid Equipment Inc,** W W Pearsall, vice-president and director. **The Fluor Corp, Ltd:** R W Kerr, president. **A P Green Fire Brick Co:** J J Offutt, vice-president and general manager.

Information Systems, Inc: W P Hooper, vice-president and general

How Commonwealth Edison Turned a Fly Ash Problem Into Profit



F-H AIRSLIDE FLUIDIZING CONVEYORS ANGLE DOWNWARD from precipitator hoppers, move air-activated ash to 20-ton central surge hoppers under floor. There are few moving parts.

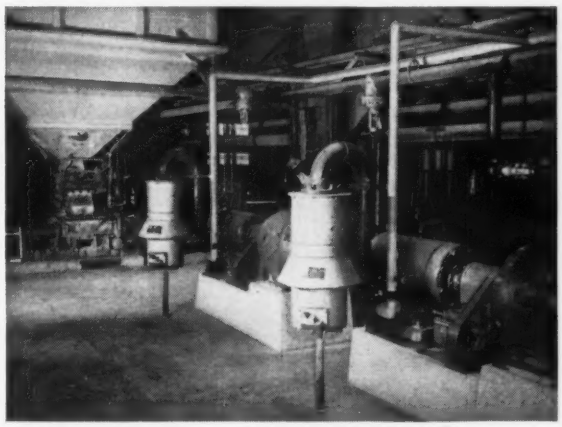
At Commonwealth Edison's State Line Station, about 350 tons of fly ash a day had to be wet down, loaded, and trucked to suitable dumping sites.

Waste becomes profit. Today, the plant burning a peak load of 5000 tons of coal daily collects dry fly ash automatically in a totally enclosed Fuller-Kinyon system. The ash is conveyed from precipitators to storage bins and silos, where it's sold as a by-product. Manpower: just three men, one at the main control panel and two bagging the ash.

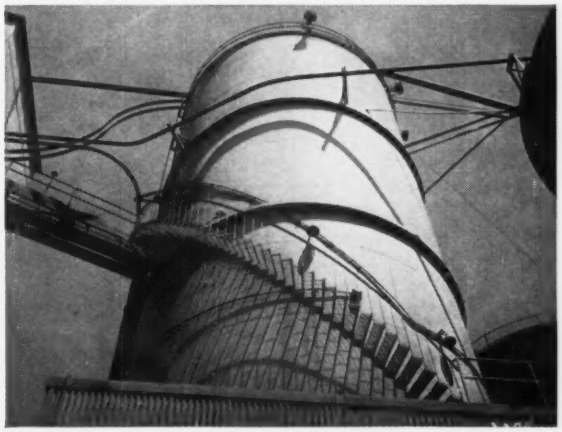
Air and gravity do the work. F-H Airslide® conveyors fluidize dry fly ash by a column of low-pressure air for easy movement by gravity to central surge hoppers. Then, a Fuller-Kinyon pump under each hopper drives the ash by air through a five-inch line to storage. The system is practically maintenance-free. There are few moving parts to foul or wear out.

Large and small plants can get the benefits of Fuller-Kinyon fly ash handling. Capacities range from 100 to 8,000 cubic feet an hour. F-H Airslide and Fuller-Kinyon conveying lines can be curved to avoid beams and other obstacles. Low-pressure air provides power inexpensively and installation costs are significantly less than other types of conveying systems. Write for detailed information in Bulletin FF-49-1.

See Chemical Engineering Catalog for details and specifications.



FULLER-KINYON PUMPS AND COMPRESSORS under surge hoppers propel ash to bins and silos at 20 tons an hour. Fluidized by air, the abrasive, 300°F. ash moves without injuring system.



BULK SILOS receive air-conveyed ash through Fuller-Kinyon pipe-lines. Farthest silo is 1,000 feet from pumps. Over 50% of fly ash is bagged and sold as a by-product.

1335A
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Appointments

Begins on page 172

manager of Panellit Div. **Keasbey & Mattison Co:** R L Lantz, vice-president. **Kaiser Engineers International,** J E Boyce, vice-president. **Leeds & Northrup Co, Systems Engineering Div:** C Nichols, manager.

The Martin Company: W S Stringham, in charge of Quehanna, Pa. lab facilities. **Oakite Products, Inc:** P J Kornett, director; J J Basch, W A Baltzell, vice-presidents. **Philadelphia Electric Company:** L R Gaty, vice-president in charge of engineering and research; C W Watson, vice-president; R F Gilkeson, manager of engineering and research dept.

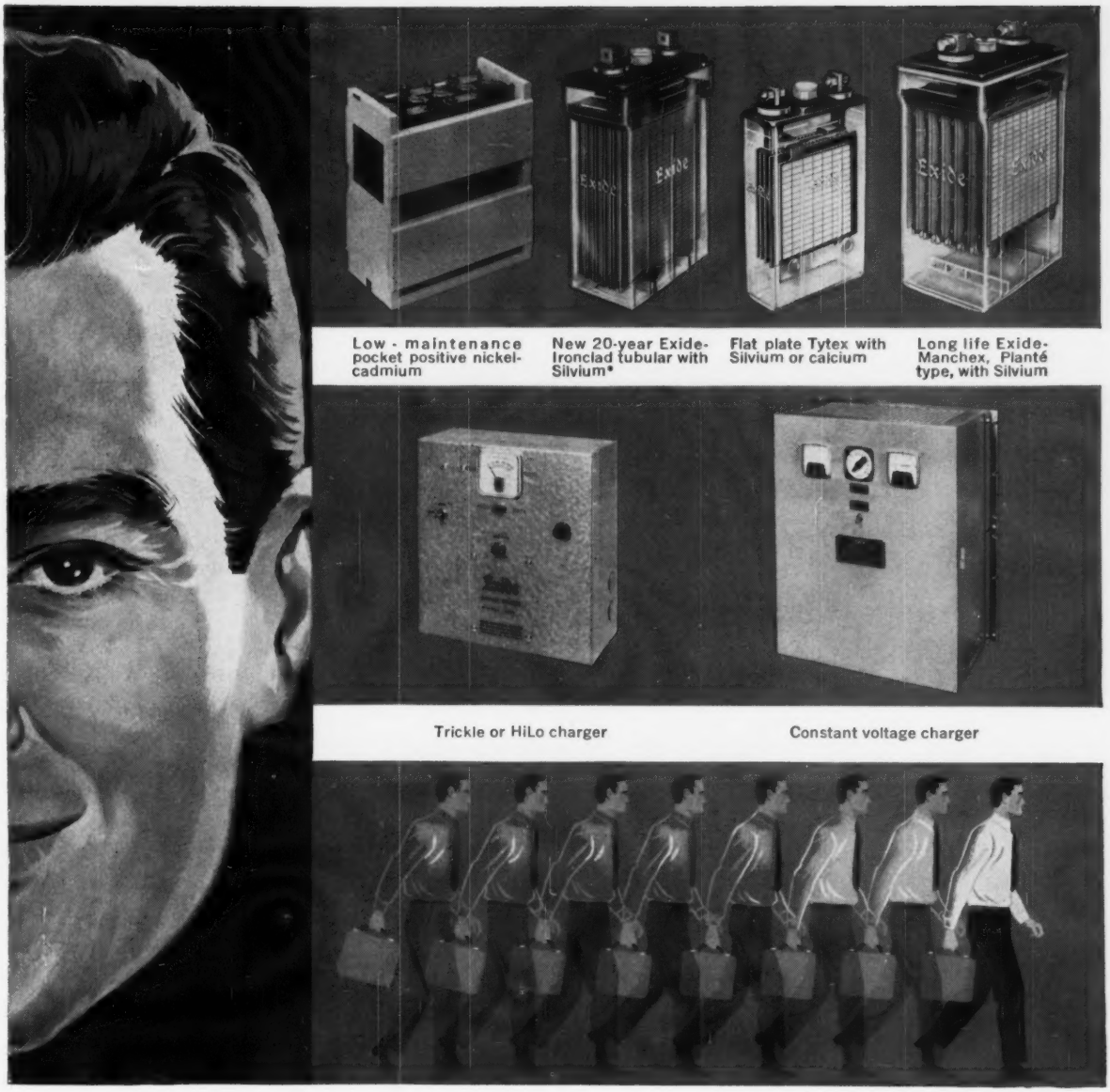
Pioneer Service & Engineering Co: W C Drummond, president. **Raybestos-Manhattan, Inc:** R B Hazard, director. **The Rotor Tool Co:** R Allchin, president. **Recold Corp:** D D Wile, E V Jarvis, C M Wilson, C R Baumhofer, vice-presidents. **Royal Electric Mfg Co:** W H Boyce, executive vice-president. **Sun Chemical Corp:** E Jacobson, vice-president.

McGraw-Edison Co, Thomas A Edison Research Labs: Dr G M Anderson, president. **Thompson Ramo Wooldridge Inc:** J H Kerr, G W Fenimore, W B Hayes, J H Shaffer, vice-presidents. **Walworth Company:** Dr F C Monkman, vice-president of research and engineering. **Wisconsin River Power Co:** M V Molsberry, president and director.

Purchase & merger

Barry Controls, Inc: merger with The Wright Line, to be known as Barry Wright Corp. **Borg-Warner Corp, Spring Div:** acquisition of Brunner Seal Company. **Crucible Steel Company of America:** purchase of 75% ownership of Fonderie Acciaierie Milanesi Vansetti, SPA of Milan, Italy.

Hewitt-Robins, Inc: approves acquisition of Union Chain and Manufacturing Co assets. **Industrial**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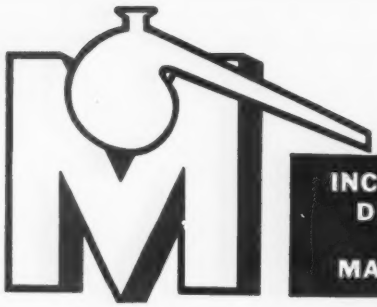
For more facts circle 320 on Reader Service card, p 101



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Appointments

Begins on page 172

Models, Inc: purchase of Southeastern Model Builders, Inc. **I-T-E Circuit Breaker Company:** acquisition of capital stock of Standard Electric Manufacturing Company. **Simplex Wire & Cable Company:** approves merger with Hitemp Wires, Inc.

Engineer changes

Allis-Chalmers Mfg Co: R P James, S N Massey Jr—Power Equipment Div; D A Koch, W A Kumpf—pump and compressor dept; J L Ficken, F J Ross—Assistant engineers, nuclear power dept. **Graver Tank & Mfg Co:** A Law, R W Briska—industrial engineering dept. **Hetch Hetchy Water and Power Supply:** O L Moore, construction engineer. **Wilsey, Ham & Blair, Engineers & Planners:** W H Gropp, chief mechanical and electrical engineer.

New names

American - Standard Controls Div; new name for Detroit Controls Div of American Radiator & Standard Sanitary Corp. **Bernhard Associates:** new firm of mechanical equipment manufacturers' representatives. **Crucible Steel Australia Pty Ltd:** Australian firm for The Crucible Steel Company of America. **Farris Industries Canada Ltd:** Canadian affiliate of Farris Engineering Corp.

Retirements

H H Burrows, senior vice-president, rubber sales for Manhattan Rubber Div of Raybestos-Manhattan, Inc, after 45 years with the company.

J Marsten, senior vice-president of International Resistance Co, after 30 years with the company.

D Sanford, executive vice-president of Union Electric Company, after more than 41 years with the St. Louis utility.

YARWAY Y news briefs

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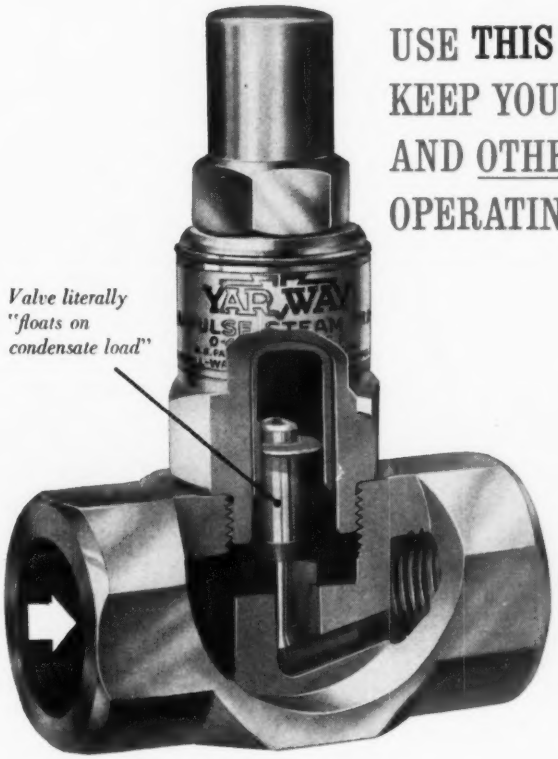

Valve literally "floats on condensate load"

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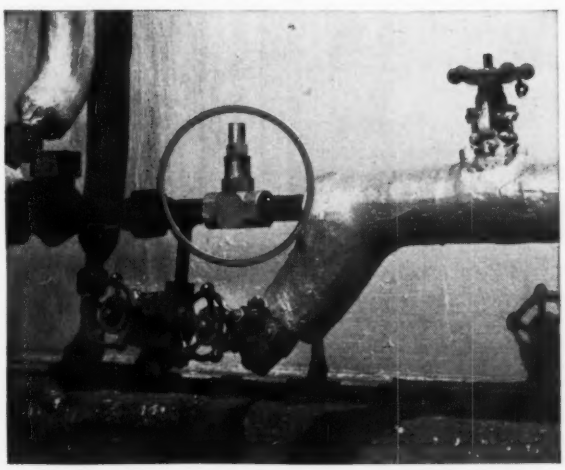

¾" Yarway Impulse Steam Trap draining tank coils on sulfur storage tank, 175 lbs. pressure

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Bookshelf

Elementary Theoretical Fluid Mechanics. *By K Brenkert Jr, Associate Professor of Applied Mechanics, Mich. State University. 348 pp, illust, tables, cloth, $7.50. John Wiley & Sons, Inc, 440 Fourth Ave, New York 16, N. Y.*

In deriving the general equations of continuity, energy, momentum and angular momentum, the control-volume approach is used because it is the most general and useful. Many of the general equations are repeated several times in illustrative examples to aid the student. Author works out examples numerically so the student has no formulas but must use the basic relationships.

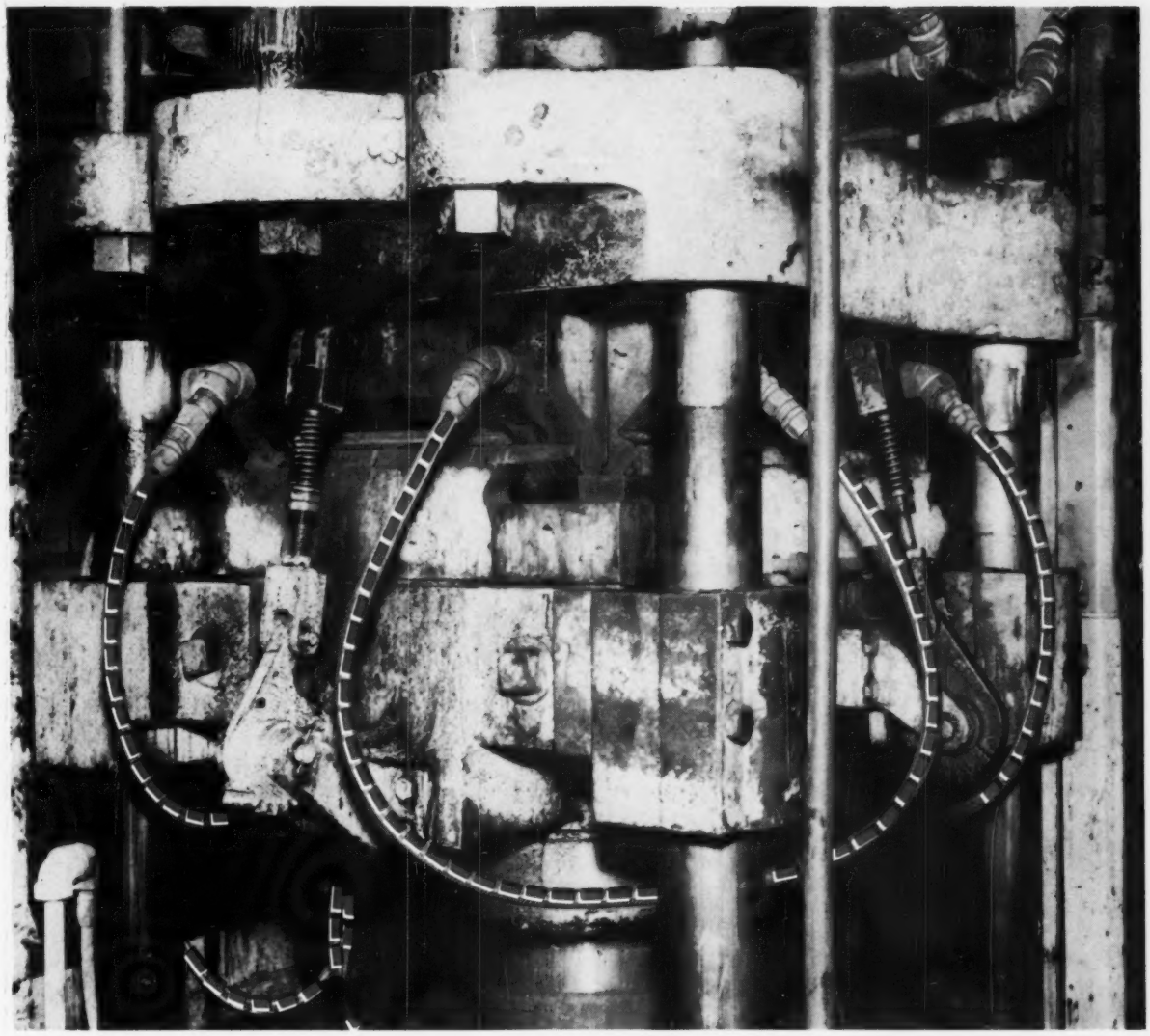
Chapter topics: definitions and concepts, fluid statics, conservation of matter and Euler equation, momentum and angular momentum, conservation of energy, friction, dimensional analysis and model study, potential flow. Book assumes reader understands calculus and differential equations.

Principles of Heat Transfer. *By F Kreith, Associate Professor of Mechanical Engineering, Lehigh University. 553 pp, illust, tables, cloth, $11.00. International Textbook Company, Scranton 15, Pa.*

Book gives some data from recent and authoritative sources but amount of empirical data included is just enough to give a broad background for using available literature effectively. There's no attempt to present rigorous mathematical solutions requiring a mathematical background more advanced than most engineering students get in their undergraduate curriculum.

Author handles heat-transfer problems by a general method in the first chapter—the similarity between equations governing heat flow and electric current. This develops an analogy between electrical and thermal systems. Then heat-transfer problems reduce to thermal networks which can be analyzed with simple and familiar principles of dc-circuit theory. This method makes it possible to consider realistic problems throughout the book.

continued



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In Canada: Du Pont of Canada Ltd., P. O. Box 660, Montreal, Que.

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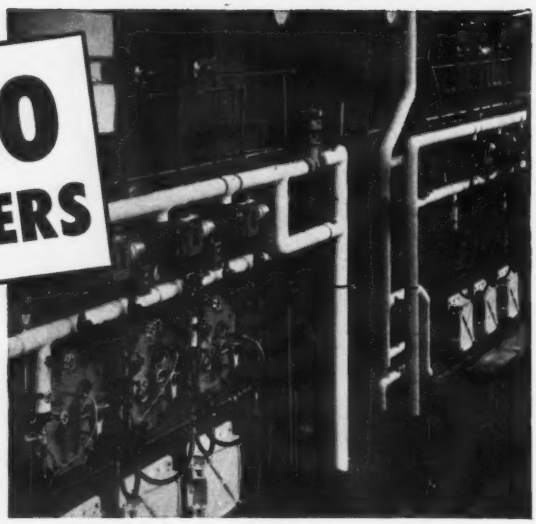

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Bookshelf

Begins on page 178

Author rounds out his approach by considering each of the basic modes, conduction, radiation and convection, in following separate chapters. This is a basic introductory text for engineering students.

The Future Supply of Oil and Gas. *By B C Netschert, Research Associate, Resources for the Future, Inc. 134 pp, tables, $3.00. The Johns Hopkins Press, Homewood, Baltimore 18, Md.*

In establishing a "resource base" for the U.S. and adjacent continental shelf, the author concludes we have on the order of 500-billion bbl of oil and 1.2-quadrillion cu ft of natural gas. These he believes available for exploitation, though they have not yet all been discovered. Using real variables — economic, technological and geological—the author sets up a new framework of concepts and definitions far more useful than mechanical extrapolation in making forecasts.

With potential ample oil and gas supply through 1975 the U.S. is not faced with urgent need to develop atomic power to keep domestic energy costs down. But the coal industry should not expect to reap extraordinary benefits in the market for energy commodities as a result of the pressure of costs on the prices of these fuels. Ample availability of crude oil gives a new perspective on the imports of oil.

Electric Power Regulation in Latin America. *By D F Cavers, Harvard University, and J R Nelson, Amherst College. 279 pp, tables, cloth, $6.00. The Johns Hopkins Press, Homewood, Baltimore 18, Md.*

The recommendations in the book are those of the authors and not of the International Bank for Reconstruction and Development or the Secretariat of the U.N. Economic Commission for Latin America, collaborators in the original study. Book concludes that the cost of electric service in Latin America should be fully met by tariffs adjusted to the needs of the industry, attracting capital as needed.

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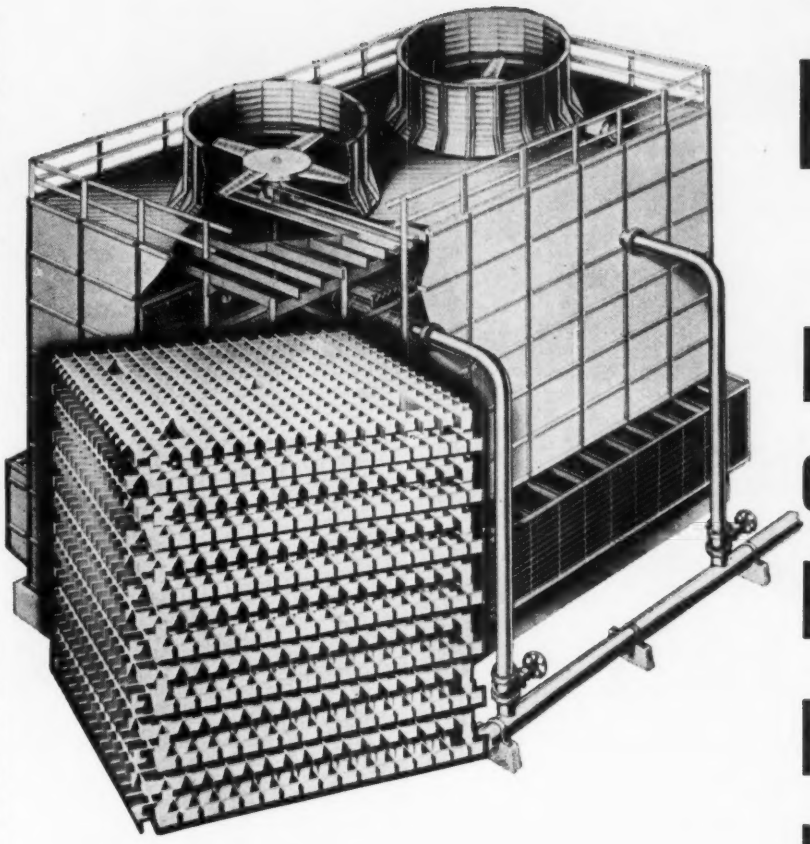

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For more information, send for Technical Paper TM-5. Fisher Governor Company, Marshalltown, Iowa. Plants in Woodstock, Ont., Rochester, England. Butterfly Valve Division: Continental Equipment Co., Coraopolis, Pa.

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Yield Strength, PSI	———	45,000* Min.	36,000 Min.
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*0.2% Offset

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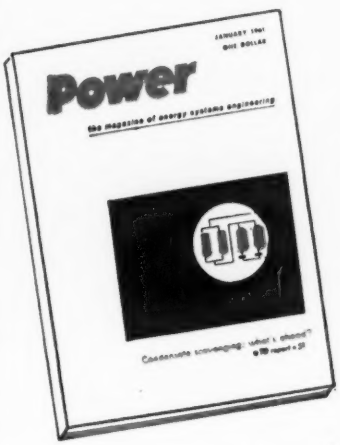

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Plant maintenance and management section

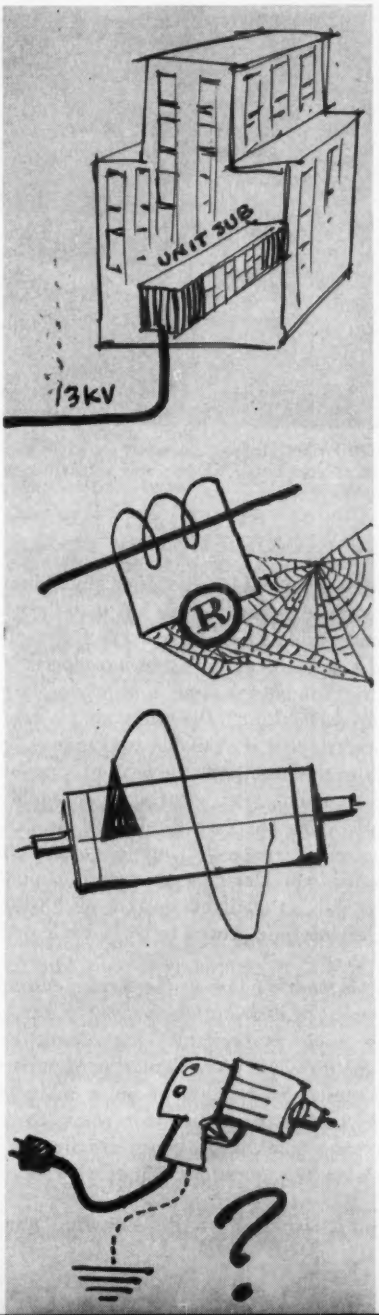
STEVE ELONKA
Associate Editor in Charge

ELECTRICAL SAFETY:

are problems mounting?

Many think they are, in spite of equipment makers' efforts to develop accidentproof gear. Misapplication and sloppy maintenance pose headaches for growing systems

By J J O'CONNOR, Managing Editor



Nobody is more safety-conscious than the man who has *recently* been exposed to an accident. This fact was driven home by the many papers at the safety-themed sessions of AIEE's Winter General Meeting held last month in New York's Statler-Hilton Hotel. It could be detected in the sincerity underlying the report of an AIEE safety task force, bringing into focus many of the newer problems of a safety nature cropping up in today's commercial buildings. It could be felt in the discussions by plant-oriented engineers when the pros and cons of systems and equipment grounding were under the hammer. It was the overriding factor in several papers covering safety aspects of current-limiting fuses and their role when coordinated with circuit breakers.

Commercial buildings were an obvious target for safety-conscious engineers. High-voltage and load-center schemes of distribution are no longer restricted to the industrial plant or central station. Higher lighting levels, greater use of business machines, expanded air-conditioning goals make today's commercial and institutional buildings vertical counterparts of an industrial electrical plan.

We find voltages up to 14,400 entering unit subs in commercial structures, and rightly so. But safety problems are being flagged because of the alarming lack of really qualified electrical maintenance and operating people in such buildings. It is rare to find men in the commercial-building area properly trained to safely operate and maintain equipment rated over 600 volts. This raises a basic question on the National Electrical Code: are the scant rules governing the installation of wiring and equipment over 600 volts realistic?

Building subs are often located in maintenance areas,

continued

'Electrical safety really starts with equipment selection

alongside heating and air-conditioning equipment, in storage areas adjacent to boiler rooms. Location of unit subs poses a number of questions: Should such equipment be installed only in locked rooms? If so, to whom should the keys be given? Is it enough to lock all cubicle doors rather than place the gear in locked rooms? What kinds of ventilating screens should be used in dry type transformers? Should conduits carrying wiring over 600 volts be clearly identified for safety reasons?

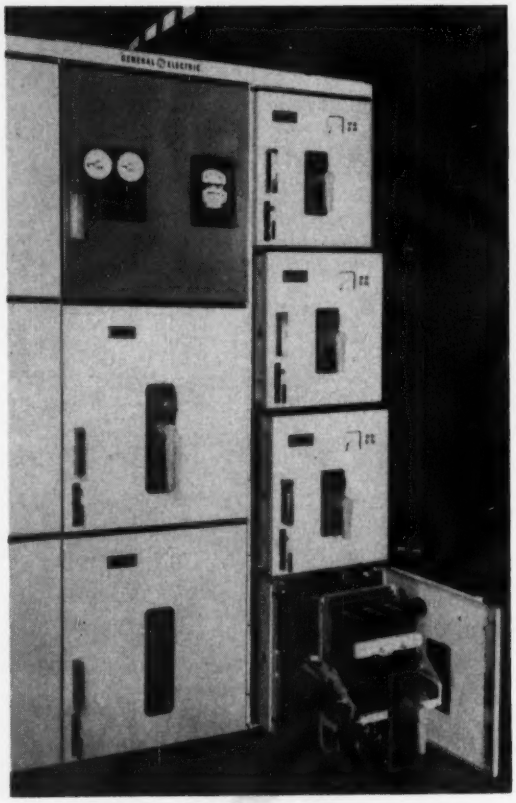
The task force working under the AIEE Industrial and Commercial Power Systems Committee tentatively suggested that all wiring equipment be completely enclosed to prevent access by unqualified people. But the same group skirted any attempt to spell out who these qualified people are. They did stress the need for locks and interlocks and, in the absence of a standard color code, they suggested using bright orange or yellow as a warning color for conduits carrying wiring above 600 volts. Color identification is most important where low-voltage conduits are installed in the same area. In discussing transformers, the task force took the obvious stand of recommending louvered vents to deflect foreign objects away from live parts.

Equipment designers are not sitting still in the midst of this need for greater safety. The truly modern secondary sub, photo, right, is a prime example of what designers can do. Through compartmentation, spread of short-circuit destruction is cut to a minimum. Complete isolation of incoming conductors from the main bus is another safety feature that is bound to pay off.

In spite of these efforts, the ever-increasing values of available short-circuit currents present increased opportunity for accident. The current-limiting fuse is one simple device which can cut electrical hazards —if properly applied.

C-l fuses are particularly useful in protecting low-voltage distribution. But because they are relatively new, hence not fully understood, there is a marked tendency to overextend their application. As pointed out by P J Reifschneider of General Electric, questions with a safety implication continue to arise in the application of c-l fuses. Typical:

When does a c-l fuse become current-limiting? The answer, in very general fashion, is simply this: When the short-circuit current is high enough with respect to the continuous current rating of the fuse, the device is current-limiting. Key thought here is that for a fuse of a given current rating, there is a minimum level of short-circuit current below which there is no c-l action. According to NEMA Standards, "An ac current-limiting fuse is one which safely interrupts all available currents within its interrupting rating and, within its current-limiting range, limits the clearing time at rated voltage to an interval equal to or less than the first major or



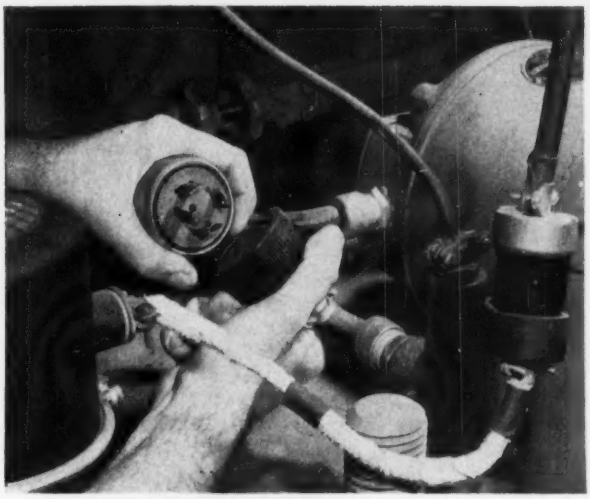
NEW EQUIPMENT designed by safety-conscious engineers is available at competitive prices; this substation is typical

symmetrical current loop duration [and] limits peak let-through current to a value less than the peak current that would be possible with the fuse replaced by a solid conductor of the same impedance."

Does a fuse always clear in a quarter cycle when it is current-limiting? Definitely not. It is not hard to appreciate that if available amperage is just high enough so the fuse limits the peak of a major asymmetrical current loop, clearing time could exceed one-half cycle. The fuse would still be considered current-limiting since clearing does occur within the first major loop. During a recent test on an 800-amp c-l fuse with an available current of 200,000 amp, total clearing time proved to be ⅛ cycle or 2 milliseconds.

Does a main c-l fuse at the service entrance protect the entire distribution system? Keep in mind that as soon as available short-circuit amp fall below the threshold level, limitation of current magnitude ceases. So whether or not a main fuse can provide backup protection for some downstream portion of a low-voltage power-distribution system depends on two questions. First, what is the level

and the adoption of sound grounding techniques . . .'



EQUIPMENT GROUNDING through quick-disconnect plugs combines practical safety and speedy replacement features

of available short-circuit current at the line terminals of the device being protected, as determined without the fuse in the circuit? Second, at this reduced level of available short-circuit current, are the fuse and device under consideration (circuit breaker) a coordinated combination?

Why all this detail about current-limiting fuses? Simply because improper application can lead to a false sense of electrical safety. Yet when they're properly applied, there are definite economic and safety advantages in using c-l fuses in combination with circuit breakers, safety switches, busways, motor-control centers. The aim here is to safely extend the application range of this equipment beyond normal interrupting and short-circuit rating.

Combination of c-l fuses with breakers or safety switches is in sharp contrast to the days of the open knife switch with the operator standing grimly on a wooden grating, keeping one hand in his pocket while manipulating live switches on an open switchboard. Recent developments in enclosed switches and low-voltage circuit breakers have clearly demonstrated that the system planner can protect his equipment and people against the effects of operating overloads and short circuits to 200,000 amp . . . and at reasonable cost.

System grounding and equipment bonding have been safety considerations since the early days of electrical engineering. And there are still problems. Unfortunately, safety grounding and allied technology are often too elementary to stimulate much interest from engineers, yet too complex for the technician or operator to fully appreciate.

There are many who feel that grounding and bonding are in jeopardy because of the ever-increasing use of nonmetallic water pipe, plastic conduit and nonmetallic sheathed cable. A mail survey showed that among representative water utilities in northern California, only 59% of the street mains, including proposed future changes or extensions, are of cast iron. Balance are either asbestos-cement, cement-coated steel, wrapped steel or other poor conductor. About 66% of the cast-iron pipe made for water mains today has a neoprene-ring type joint, thus ruling it out as a current-carrying medium. Of the water-utility companies responding to this survey, about 25% use an insulated fitting at the main where the customer's tap is made. In light of these facts, C F Dalziel of the University of California suggested that we review the hazards incidental to using the neutral wire as a general ground wire and honestly inquire if the idea is as bad as formerly believed.

Whether we like it or not, grounding and bonding will become increasingly costly and difficult. And, according to Dalziel, we will be fortunate if we can get the neutral wire to act also as a ground wire and wind up with at least one effective ground on each utilization circuit. Many European communities steer clear of metallic conduit or metallic sheaths for bonding. Their experience with loose lock nuts, rusty threads, poor couplings has been far from satisfactory. They either install a separate bare or insulated ground wire or permit use of the neutral as a combination grounding and bonding wire.

Electric-shock data, obtained from the work-injury reports of the Industrial Safety Div of California's Department of Industrial Relations, show about one person in six receiving an electric shock because frame, case or non-current-carrying metal part of the equipment was not properly grounded. With effective grounds, most or all these injuries could have been prevented.

Many electric shocks and burns would not happen if the user of power-operated tools followed a few simple rules: Start by examining the equipment for obvious physical defects. Then operate the tool on a dry insulated floor away from all grounds. Moving a portable tool, watch for sparks as the frame makes contact with a ground. Then, holding the tool in one hand while it's running, gently brush the back of the *same* hand to ground. If practical, reverse the plug and repeat.

Portable tools equipped with extra insulation also have a place in industry, according to D M Manson of the CSA Testing Labs in Toronto. Idea behind extra insulation is merely providing additional insulation on top of that normally used and dispensing with the traditional frame grounds. These tools are finding their niche where it's simply impractical to maintain a ground.

continued

continued

. . . maintained through periodic tests of protective gear

What factors contribute to the shock hazard of portable electric equipment? The first is size. Small tools are more difficult to insulate than large stationary equipment. They are used while making close body contact. By their very nature, portables get rougher treatment than permanently fixed electrical equipment.

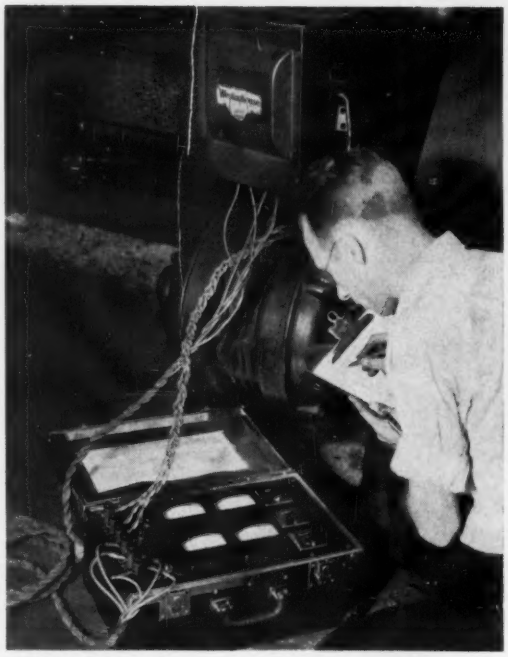
As reported by J L Bennett of Black & Decker, the accident rate for portable equipment is higher than for any other type energized by utilization voltage. Majority of accidents could be prevented by proper grounding or double insulation. Faulty cable contributes significantly to the hazard. At this point it is interesting to note that Dr W B Kouwenhoven, a top consultant on electric safety and lethal effects, reports that of all the shock accidents he has investigated, not one involved equipment which was properly grounded. Although it's easy to build up a strong case for grounding, fact remains that all too often the grounding provision is ignored by the tool operator or in some cases by the electrician making the original installation. Thus the concept of double insulation, which shows signs of catching on.

Double insulation of portable tools is becoming increasingly popular in Europe. If double-insulated equipment can be properly manufactured it can boast some advantages over single-insulated equipment requiring grounding for safe operation. The preferred double-insulated construction would have its exterior housing of insulating material to serve as a backup should both insulations fail.

Only a few tools of this type have been made to date. Major deterrent has been availability of proper housing materials having stability and strength to withstand temperature gradients and inherent rough handling. Electric razor is an outstanding example of an insulating housing serving well a potentially hazardous appliance. Available information points to but one fatal accident in the United States directly traceable to an electric razor. But until such time as the double-insulated portable tool with an insulated housing is readily available and has proved completely safe, let's make every effort to further the case for grounding portable electrical gear.

Rectifier users contributed their thinking on safety in the form of a survey run by AIEE's Industrial Power Rectifier Committee. From 63 sources representing electrochemical, steel, transportation and other industrials, questionnaires brought to light safety-oriented practices associated with the operation and maintenance of excitrons, ignitrons, multianodes, semiconductors, mechanicals, m-g sets, rotary converters and glass-bulb high-vacuum rectifiers.

Of those responding to the survey, 83% claim their big hazard comes in the course of minor maintenance or checking on operating equipment rather than during major maintenance or on shutdown. How serious is that hazard? 63% stated their rectifier equipment is repaired or maintained while energized: with some this is a matter of daily practice, for some done only in an emergency.



REGULAR TESTING of each protective element insures the continuity of all safety features you paid for initially

Interesting item: Over 2-million man-hours are spent every year operating and maintaining rectifiers. During the last three years only 21 lost-time accidents were reported, costing industry a modest 387 man-days. And there were but nine deaths linked to the rectifiers represented in the survey, over the entire life of the units. Although we can never relax in our pursuit of higher safety standards, results of this rectifier survey are heartening considering the inherent hazards involved.

Rectifier specialists know that much testing is carried out with the equipment energized. And nominal voltage levels often exceed 600 on the frame of the equipment. Adjusting ignitor tips and trouble-shooting in the firing-control circuits is generally done with the rectifier on line. Perhaps the reason for the good safety record is the long hours of training necessary to develop people who can be trusted with costly rectifier gear: a side benefit, if you will, but mighty important.

Relays are still another potential source of elec-

by men who are fully trained in all facets of their job'

CAREFUL TRAINING of your men is, in final analysis, the most important yet most fragile link in the safety chain

trical-safety problems if neglected. The generally well-engineered protective plan, as outlined by the electrical engineer and installed under his direction, goes for naught if maintenance falls short. No induction type relay system can be expected to operate successfully in an emergency if maintenance is limited to occasionally dusting the relay cases. Periodic tests must include a time check on the instantaneous and time-delay trips, test of the trip circuit with actual operation of the circuit breaker, an impedance reading on the ct secondary. Although this is "must" procedure for a safety-conscious plant, it is a chore often farmed out to the utility company or neglected altogether.

Recognizing that all too many industrials treat this matter of relay protection too lightly, the Mutual Boiler and Machinery Insurance Co have set up a Technical Service Div offering an integrated engineering, relay and circuit-breaker testing service. But any testing program must go beyond the routine. It must periodically review the coordination of all protective devices, since industrial electrical systems are ever-changing.

The ultimate answer, if there is one, lies in more-effective training of all who come in contact with electrical systems. About 50 years ago industrial injuries were accepted as an inevitable result of the manufacturing process. This attitude of indifference was shared by management, employees and the general public alike. According to J T Seaman of Gary Steel Works, reversal of this passive acceptance philosophy for U.S. Steel began in 1910 with the creation and adoption of the safety-first theme. This change in attitude was, according to Seaman, more important than any technical achievement. Following on the heels of this new attitude came a step up in safety training for U.S. Steel and industry in general.

Safety rules at Gary are many. Typical: Each man doing a job is observed on a planned basis at least semimonthly. Any deviation from safe electrical practice is noted and corrected on the spot. Disciplinary action follows if a man continues to break rules designed for personal safety.

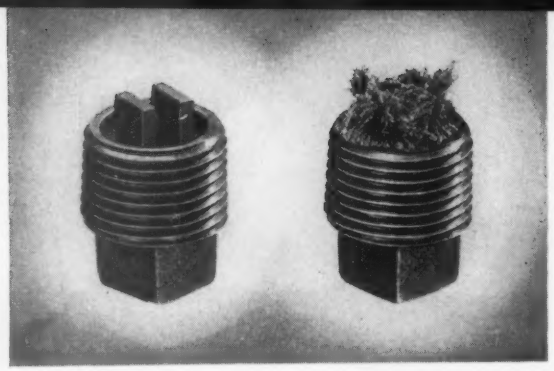
To work on underground circuits at Gary, where the voltage exceeds 500, all power must be off. Those in charge of the job make certain the cable conductors are disconnected and grounded at all supply points before work is started. Then a foreman identifies and marks the cables to be worked on. This corresponds to everyday practice in any well-run utility company.

Where circuits on a pole or tower must be worked on and cannot be de-energized without interfering with plant operation, a safety man is assigned to the job. He has the specific assignment of observing movements of each lineman to prevent unsafe practices from creeping in.

Cases in point of safety rules and practices could be recited at length, possibly with some good effect. But in the final analysis electrical safety depends on people: well-trained people on both design, operating and plant-maintenance.

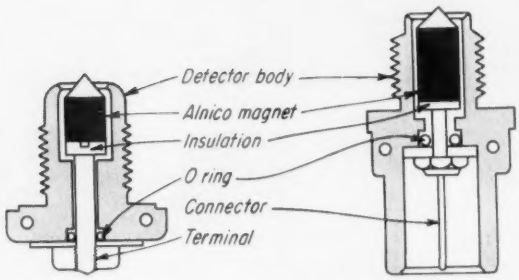
Correction

In February's *Printed-circuit motors: how far will they go?*, pp 74-75, we stated: "Riveted and soldered connections are made between faces. . . ." This is not correct; connections are made by means of plated-through holes. This technique was the major technical contribution toward making the invention practical, according to the manufacturer, Photocircuits Corp of Glen Cove, N. Y.

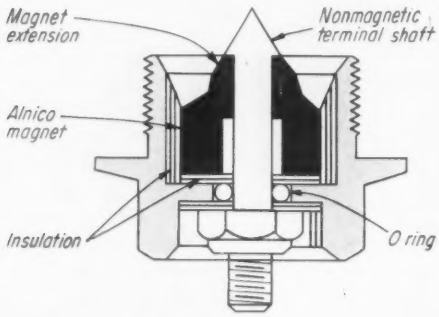


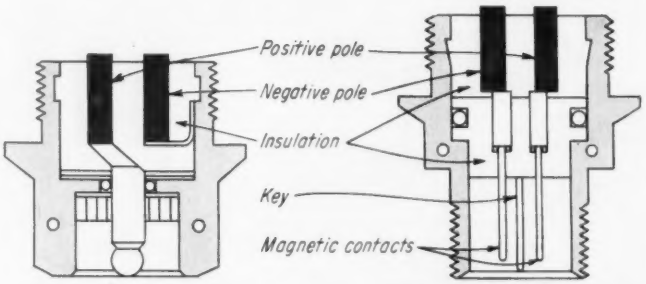
BEFORE AND AFTER doing guard duty in gear transmission—pictures show how detector collects metallic particles to protect gears

Magnetic chip detector



CONTINUITY TESTER GROUND-RETURN SYSTEM





CONTINUITY TESTER INSULATED RETURN SYSTEM

CHIP-DETECTOR FEATURE lets maintenance man check on accumulated ferrous chips without taking time to drain the machine

FOUR DESIGNS with special features—depending on the service. Check pros and cons of all four before you decide on any one

By STEVE ELONKA, Associate Editor

OPERATORS' NOTEBOOK 147

This tiny plug reduces wear

Any item promising to reduce wear deserves a good hard look in view of today's upward-spiraling maintenance and equipment costs. Such an item can provide value far beyond its purchase price for preventive maintenance.

This tiny magnetic plug is a candidate for just such a spot. But because it is often a small part of a complex and expensive mechanism, many designers and maintenance people have completely overlooked it. We feel this plug is important enough to have us tell you what it is, what it does and how you can apply it to your machinery to do its job best, reducing costly damage and outages.

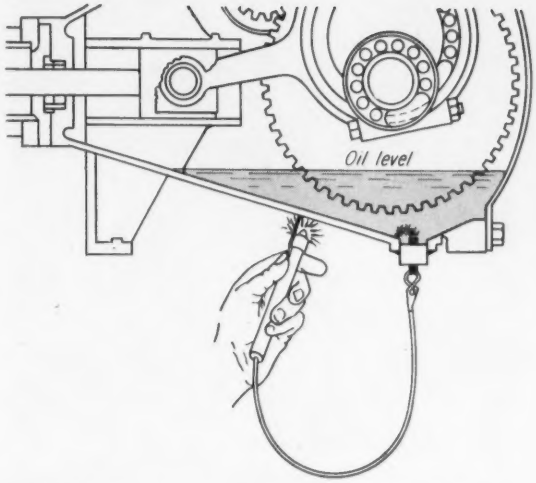
Major gremlins in any machine using flowing oil are abrasive ferrous-metal particles that wear away from the machine components. Unless eliminated, these particles circulate with the oil, scoring and pitting bearings, bushings, raceways, gear teeth and even cylinder walls. Just one tiny bit of free metal in the oil system can result in excessive heating, noise or early failure, depending on where it lands. It's a safe bet it'll manage to do some damage.

Magnetic plug goes right into the oil or hydraulic-fluid stream. The plug can be installed in any engine, transmission, differential, hydraulic system, gear box—wherever parts move in a fluid—and the magnet extends into the fluid. As the oil circulates, magnetic plug picks up and holds suspended ferrous particles so they can't recirculate through the bearings, gears and other critical parts to do damage. After 500 hours' initial operation the magnetic plugs are removed and cleaned. Then after each additional 5000 hours of operation they are again removed, cleaned and reinstalled. Meanwhile, they can be tested in place.

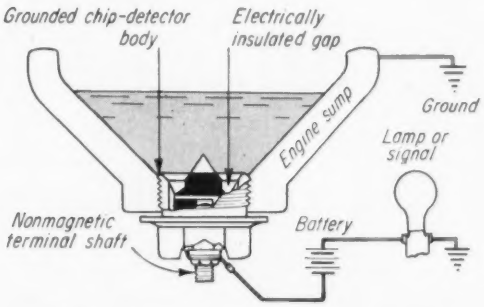
The Ternstedt Div of General Motors Corp, for example, locate these magnetic plugs in the crankcase of their lube pumps where they can do the most good. Ternstedt finds this increases life of pump parts from the former 1 or 1½ years to 3 or even 5 years, depending on service.

Basic design of the magnetic plug looks about like any oil drain plug. Big difference—which changes it into a vital preventive-maintenance tool—is a powerful per-

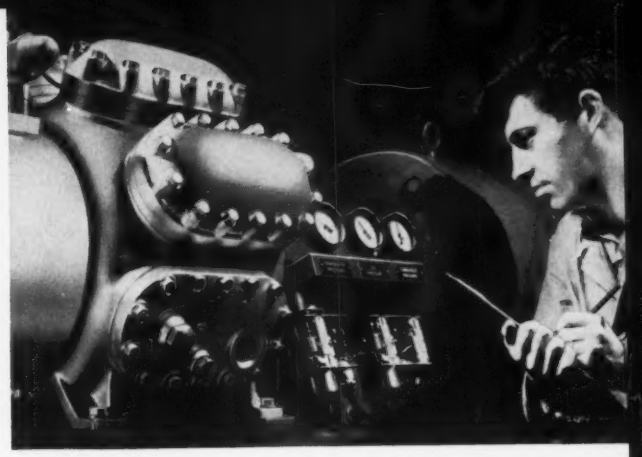
plugs and tests



TESTING for loose metal particles at set intervals with hand tester can increase operating life of this pump several times over



ELECTRICAL CIRCUIT is completed when metal particles bridge the gap between crankcase and magnetic plug as shown above



STANDARD today on many quality pieces of equipment, these magnetic plugs go far toward insuring long life, good performance

manent cobalt or alnico-5 magnet anchored in the plug body (see *Plant Electrical Fact File No. 49, Magnets*, POWER, July 1960, pp 190-191).

Under normal conditions the magnets used in these plugs lose less than 10% of their strength during a 10-year period of service. So for ten years they're strong enough to collect all the ferrous particles floating in a liquid, provided they are properly located and cleaned off occasionally.

Magnetic chip detector, above left, is added to the plug, does the same job but goes one step further. You can inspect the chip detector for metallic deposits without removing the plug. This inspection takes a matter of minutes, instead of the sizable chunk of time needed to drain the machine before plug can come out.

As sketch shows, business end of chip detector is a magnet, separated from the base of the plug by insulators. When system debris builds up—a large chip or enough smaller pieces—it bridges the gap between magnet and base of plug. At inspection time, the mechanic checks the plug by applying a continuity meter or similar electrical instrument to the exposed side of the plug. If the insulation between the magnet and the base of the plug has been bridged by metal particles, the electrical equipment lights up so the mechanic knows it's maintenance time. If the equipment doesn't light up, particles haven't bridged the gap across the insulators. Then maintenance man is sure there is no dangerous amount of ferrous material in the system.

More-sophisticated application uses the plug to indicate pending internal trouble. A positive reading on the continuity tester tells maintenance man it's time to analyze the deposited material—often a clue to trouble source. Excessive deposits can mean the unit is disintegrating internally. This is a warning that repairs are necessary to avoid a future failure. Detector plugs can be wired permanently, too, so a warning light or other device will show accumulation of ferrous particles the moment it occurs. Sketch, left, shows an electrical-circuit system.

As warning devices, magnetic plugs are widely used in the aviation industry. Regular inspection gives advance warning of impending internal breakdowns—cuts chance of in-flight failures.

Some applications of these plugs in the many energy systems are shown above. 500 different types and sizes are made by the Lisle Corp of Clarida, Iowa. Magnetic plugs find their niche in many modern engines, transmissions and differentials; in pumps, speed reducers, aircraft accessory drives, constant-speed drives, compressors, hydraulic presses and jacks; in refrigeration and air compressors, diesel engines—everywhere flowing fluids are applied to reduce friction, wear and heat. No design changes are usually needed—just substitute for present drain or fill plug and you are in business.

Plug location must meet three requirements: (1) magnet must come in contact with the fluid while the assembly is in operation (2) the plug should be located where active circulation takes place—usually the drain or fill hole (3) the plug should go in a spot where it can be conveniently serviced. Regardless of what equipment you put these plugs to work in, it will pay you to to consider them in your preventive-maintenance program.

Plant expansion and added portable air tools often tax installed compressor and piping capacity to the limit. Then low pressure at the tools cuts into production efficiency. Maybe it's time you checked into . . .

The high cost of low air pressure

By H P BAILEY, The Rotor Tool Company, and
R P KYMER, Cooper-Bessemer Corporation

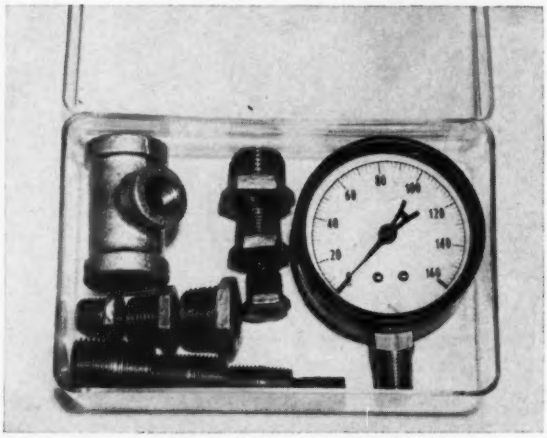
SCREWDRIVERS operating at less than rated air pressure can have a bad effect on production quality—fail to set up tight

Portable air tools—and most other air-operated equipment, for that matter—are usually designed to operate at 90 psi for maximum efficiency. Most production people know that low pressures, 50, 60 or 70 psi, at any air tool reduce horsepower available to do work and thus cut production efficiency. But how much efficiency is lost because of inadequate air pressure? This loss can be estimated in terms of dollars, a good basis for evaluating new air-compressor capacity.

The evaluation process is really a combination of two sets of figures. One, prepared by the manager responsible for shop production, shows production losses because of low air pressure; the other, prepared by the manager responsible for plant services, shows the cost of new air-compressor capacity. Neither one of these people alone can fill in the picture; it takes their cooperation to produce a good evaluation on which to base plant-addition needs and detailed specifications.

Measuring air pressure at the tools is the first step. But you have to be careful not to be fooled by losses between the point of measurement and the tool itself. Only pressure the tool knows is that inside its operating cylinder. The usual but inaccurate method of measuring air pressure is to insert a hypodermic-needle air gage in the hose close to the tool. But what if the quick-detachable coupling between hose and tool is too small? And it usually is! Pressure drop through the coupling can go as high as 20 psi in extreme cases; it's usually 5 to 8 psi even under favorable conditions. Then you get a false reading and are apt to blame inefficiency on the tool itself.

Better way to measure air pressure accurately at the tool: mount a tee on the tool proper, between tool and coupling. Then an air gage on the tee will show real tool pressure. A convenient kit, above, will do the job in most cases, and it's a good idea to add it to your tool box for on-the-spot checks. Many tests made in a wide variety of plants show pressures measured at the tool *in this way* are quite commonly 70 psig, often 60 and sometimes as low as 40 psig—less than half of rating!



AIR-LINE TEST KIT includes all fittings you need to get a good pressure reading *at the tool*. Only this tells real pressure

Another factor: shop people normally choose the lightest air tool that will do the job rather than a heavy-duty type. And these light- or medium-duty tools suffer even more from low air pressure—further reducing tool effectiveness and raising production costs sky high.

How much does low air pressure actually cost you? Production tests give the best answer. But there is a simpler way to get an idea of what's involved. For abrasive tools, take a weighed block of your production ma-

GRINDING TESTS on production materials show effect of pressure increase. Grind at different pressures, left, then weigh-test carefully, right, to find amount ground away at each pressure. This is a good, simple way to pin down your efficiency gain accurately

terial and grind away at it for a timed period. Then weigh the block. Try this at several pressures to get an accurate record of pressure effect. (You may have to wait until night or over a weekend when other plant loads are off the line to get a true 90-psi test.)

Productivity tests will vary between new and used tools. Some general results can be expected for new tools: Increasing air pressure at the tool from 70 to 90 psi shows a corresponding increase in hp, but actual metal removal gain will be somewhat less. Increases from 60 to 90 psi raise hp about 50% and metal removal is higher. Increases from 40 psi (an inexcusable condition) to 90 show hp gain of about 125%; metal removal increases much more. In this latter extreme case, tool is barely operating—at low speed, low hp and very low efficiency.

For older tools repaired to 80% of their original power, metal removal in all cases increases much more rapidly than hp. And don't forget that in most shops air tools are not new. Overall improvement is apt to be greater than would show up in tests using new tools only, but it's unlikely to be more than 83% of new-tool production.

For other air tools such as nutsetters, impact wrenches and chipping hammers, you'll probably need to go to on-the-job production tests. Here again, you will probably have to run tests at night or over the weekend to be sure you have 90 psi at the tool. Also check for improved quality—at low pressures the nut probably doesn't set as tight as it should. This is hard to evaluate, but a good set is, of course, a definite plus.

Now you are ready to convert improved production efficiency into dollars and cents. One way is to count men whose work is slowed by low pressure, multiply by their pay and get an annual figure. But this usually gives an exaggerated picture—tools are never used 100% of the time. You will have to arrive at your own individual use factor to reflect the actual conditions in your plant.

Use factor will vary widely between production operations; you have to take into account trips to the washroom, coffee breaks and time to get materials delivered to the workbench. In some specific cases proportion of time tools are actually used averages out to 25 to 50% for light and heavy grinding operations, 10 to 40% for chipping hammers and 40 to 80% for screwdrivers and nutsetters. You'll have to check conditions in your own plant. Be sure to be realistic in setting each factor—the aggregate can make or break your evaluation and the results you get.

Table 1 shows typical portable-tool payroll costs for various use factors based on an average rate of $2.50 per hr, 40-hr week and 50 weeks per year. Annual cost works out to $5000 per man. Loss of production efficiency, then, is a function of these costs and is your basis for determining ability to pay for improved plant air pressure.

What improvements will you make? Before going all the way back to the compressors, check your distribution system. Plant expansion and added air-operated tools may have loaded it to the point where no matter what the air-compressor capacity, you won't get much better results at the air tools. First check distribution-line sizes. Stack them up against the *Compressed Air Handbook* to see whether your present system is capable of delivering enough air to the tools. Valves, hose and couplings must also be large enough—check inside opening, not just nominal size.

Condition of distribution system is important. Over the years it may have accumulated a lot of rust, cutting down effective inside diameter. Old hoses may have been repaired with ¼-in. pipe, strainers may have plugged up. Start right at the air tool and troubleshoot pressures all the way back through the system. Correcting system faults

you find usually costs little and is well worth the money.

But if the system is OK, next step is to find out how much more air capacity you actually need. All you have to do here is divide pressure needed by average pressure found at the tools. Example: you want 90 psi but find that 70 psi is average. So 90/70=1.28—you need 28% more capacity. Table 2 shows needs for other low-pressure conditions.

What will this added capacity cost? To find this figure you must take the compressor's price, add cost of the driving motor and controls, piping, installation, air receivers and aftercoolers. But extra costs can be approximated rather closely for estimating purposes.

For single-stage compressors widely used in the range of 240 to 515 cfm, add about 65% to compressor cost. In these sizes you probably have to add certain accessories normally included with a larger machine. For 575 to 800 cfm, 2-stage compressors are usually justified, but added cost remains about the same—65%. For the range between 800 and 1400 cfm, two half-capacity compressors would be normal. For larger sizes: add 55% for 1400 cfm, 50% for 2000 cfm, 40% for 5250 cfm.

Example: a 2-stage heavy-duty compressor for 800 cu ft might cost $18,000 including motor. Add 65% for the rest of the necessary installation and use $29,700 as your total installed cost for estimating purposes.

What will running this added compressor capacity cost? There are two figures to find: (1) What will it cost to run your present compressors higher? (2) What is the operating cost of the new compressor capacity? In our sample evaluation we have lumped these two costs for convenience and used 1¢ per kwhr. If your rate is different, of course, you'll want to change this figure.

Now let's run through a typical evaluation to find payout time for added compressor capacity. Evaluation summary is shown below. We assume 100 operators at an hourly rate of $2.50 and a use factor of 50%. Our present average air pressure at the tools is 70 psi; we want 90 psi for maximum efficiency. This means we need 28% more capacity than our present assumed 3000 cfm.

Added weekly operating cost is $65.36, table 3. This lets us figure a weekly dollar value for added production. We then divide this weekly gain into the total installed cost of the 800-cu-ft compressor and get a payout time. In our case it's 53 weeks.

Note especially the effect of use factor in this evaluation. Had it been 25%, payout time would have gone up to about 80 weeks; for a 100% use factor, it would have been only 25 weeks.

Here you can see just why evaluation of added air capacity takes the active cooperation of production and plant-service departments. Former works up worth of production increase, latter, cost of added air capacity and power; *together*, they combine these figures and arrive at a payout time.

Now it's up to management to say whether payout time is acceptable. A plant usually has its own established payout time against which it measures each and every plant improvement. This may vary from six months on up.

Yes, low air pressure can erode away profits by upping production costs. Low pressure may not stand out like a sore thumb, but it's there. It's up to you to find it, evaluate it against cost of more capacity and then decide whether the game is worth the candle. This is the only way to beat the high cost of low air pressure.

Factors to evaluate air-capacity needs

1 Careful assignment of use factor is a must. It can make or break your study

Use factor	100%	50%	25%
Employees	—Annual cost, dollars—		
10	50,000	25,000	12,000
50	250,000	125,000	62,000
500	2,500,000	1,250,000	625,000

2 Additional air capacity needed to get 90 psi ties to present air-tool pressure

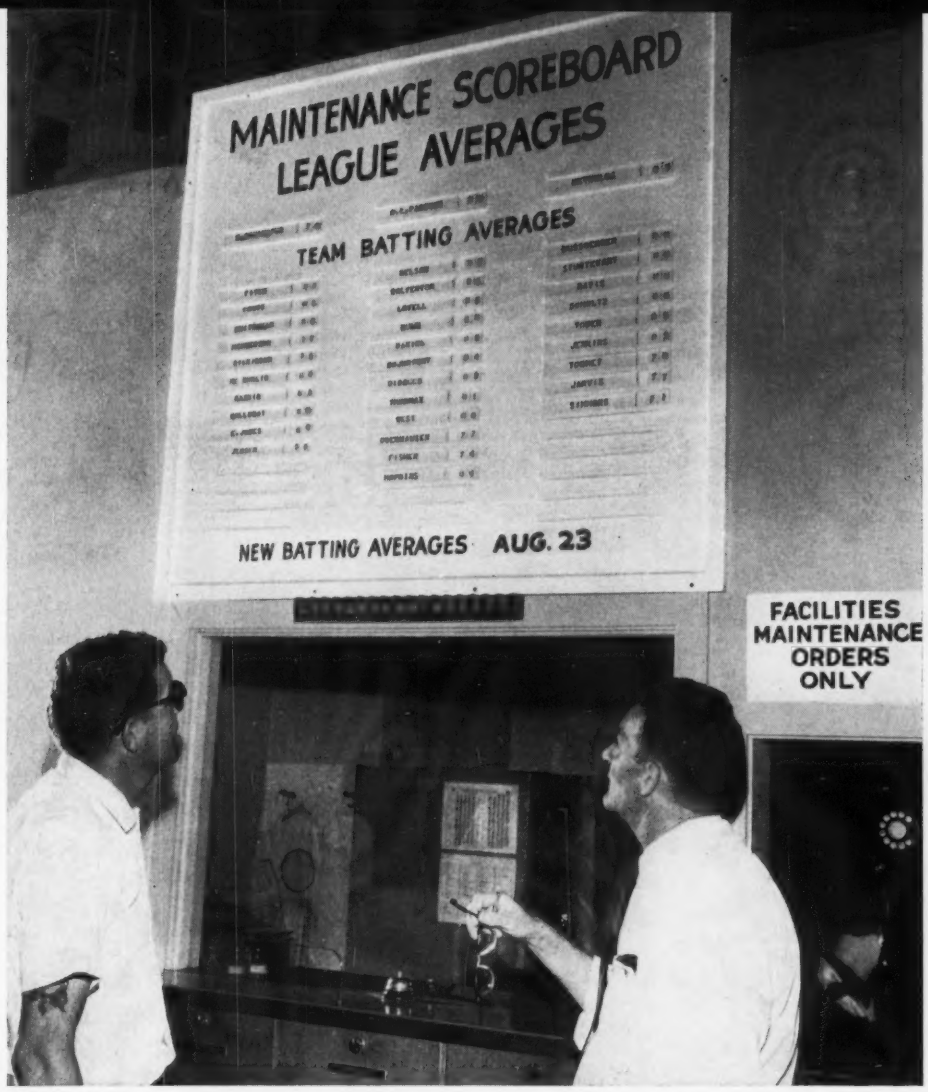
Present average tool pressure, psi	Additional capacity to get 90 psi, % of present capacity
40	125
50	80
60	50
70	28
75	20
80	13
85	6

3 Power cost for added air includes new equipment and pressure increase on old

Present average tool pressure, psi	Added power cost for air, $ per 100 cfm (basis, 1¢ per kwhr)
50	2.90
60	2.50
65	2.12
70	1.72
75	1.31
80	.89
85	.45

Here's a typical evaluation for increased air

A	Actual portable-tool payroll affected per week, $	5000.00
B	Increased production available from pressure increase (70 to 90 psi at tools) based on production tests, %	12.6
C	Value of increased production, $ (*A* × *B*)	630.00
D	Cost of additional power, $	65.36
E	Net value of increased production, $ (*C* – *D*)	564.64
F	Added air capacity, cfm, (28.6% of 3000 cfm)	858
G	Cost of new 800-cfm compressor installed (standard unit size), $	29,700
H	Payout weeks (*G* / *F*)	53



With "major-league" scoreboard to build esprit de corps . . .

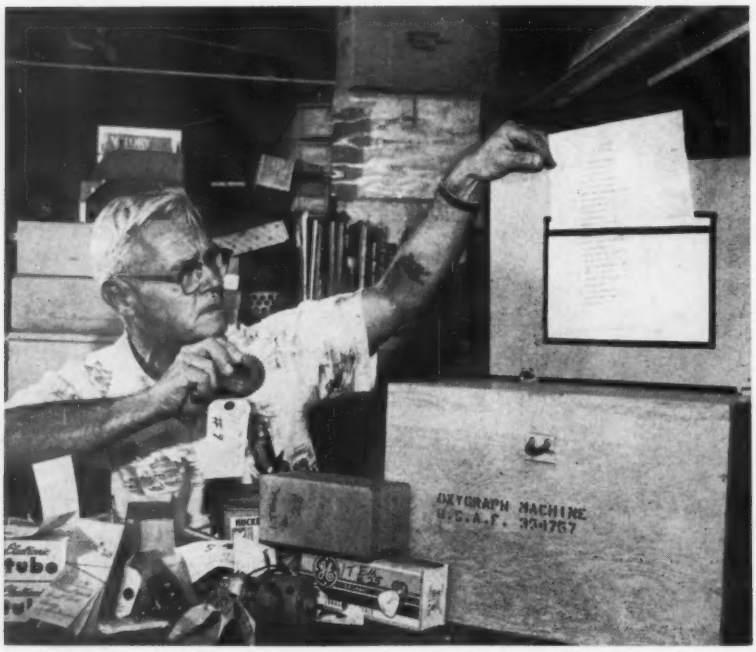
Rohr Aircraft Corporation cuts downtime to the bone

By STEVE ELONKA, Associate Editor

Esprit de corps is the watchword of the maintenance department as they keep the giant Rohr Aircraft Corp plant rolling in Chula Vista, Calif. And one of the reasons for that is ex-navyman John Malloy, maintenance superintendent. To put it in a few words, John runs a "tight ship."

Maintenance scoreboard, above, is one example of what I mean. At left is K L Wolverton, assistant foreman, eyeing his 96% realization record on the maintenance-batting-average board. At right is Jack Malloy, putting in a good word to keep the records high. "Batting averages" are based on man-hours for maintenance jobs. A 100% record would mean Wolverton's crew had completed every job assigned it in theoretically perfect time. Names on this board are those of assistant foremen—and each one tries to keep his name at the top. That builds the friendly rivalry which pays off in efficiency for the

"PANIC-BUTTON" light (indicating a breakdown in a production machine) is answered by assistant foreman while maintenance dispatcher fills out the proper work-order request



SPARE-PARTS MAN checks item against inventory list attached to top of Navy-style parts box. Each item has its number attached; number is also listed on inventory sheet

Good maintenance

department. Let's take a close look at this department and see what makes it so successful at paring downtime to the bone.

Rohr Aircraft Corp is a subcontractor, producing major flight components of all kinds. The Chula Vista plant is one of three. Currently they are building jet power pods (housings) and other components for the large aircraft companies.

Maintenance organization. Chula Vista has about 8000 people of whom 291 work in the maintenance department. There are 6 group foremen and 23 unit foremen. Each unit foreman has about 13 men in his crew. Various specialized craftsmen are distributed in each crew so any one crew always has at least one man ready to tackle any job.

Planning. An organization this big demands careful paperwork to avoid waste and mismanagement. The engineering and management department plans and approves projects, issues work orders and assigns work-order numbers. The maintenance superintendent receives these work orders, checks them, approves the projects for shop work.

Maintenance dispatch desk next gets the approved work orders and projects, assigns a log number to each work-order request. Maintenance foreman then reviews each job, establishes labor, parts and material requirements and schedules the orders through leadman involved. From there the master scheduler and manpower-control department take over.

Log numbers for each work-order request are in code, with urgency ranging from 1—panic button! to 9—routine housekeeping to be done when convenient. For example, work-order 114393 indicates "panic-button" equipment breakdown because 1 is the first digit of the log number. Work-order number like 217201 means job is urgent, indicated by digit 2. Number 998742 shows work-order request was initiated by plant engineering; 9 as first digit means it's a routine housekeeping job.

Preventive maintenance. Periodic and routine inspection checks

organization keeps the Chula Vista plant rolling right on schedule.

and repair schedules originate at the preventive-maintenance files. These include master machine record, machinery lubrication, automotive lube, production-machine check, maintenance-dept preventive-maintenance investigation report. The tickler file records schedules at correct intervals. When it's time for maintenance, applicable work-order forms are initiated in each case to cover the work indicated. The work orders go to the master scheduler and manpower-control desk, from there to the leadman's schedule board.

Emergency work is probably the most interesting part of the maintenance setup. Because downtime can be so expensive in a plant of this size, every effort is bent toward completing emergency work fast.

The emergency call comes in to the maintenance dispatch desk, left. Dispatcher pounces on the "panic button," flashes a red light to the shop area, and the nearest assistant foreman rushes to the window. He waits while the dispatcher fills out a work-order request based on info coming in over the phone.

Performance. Once the work is scheduled and the work order issued, performing takes over from planning. Same routine holds good whether work is emergency, a planned project or preventive maintenance — with panic-button emergencies taking A-1 priority.

Leadman distributes work orders to the mechanics in his group. Mechanic ready for the next job gets into action, records his starting time. He lists materials required on a materials-requisition form and draws items from the stock room.

After mechanic does the work called for on the work-order request, he notes any additional work he has done or materials he's used. With job finished, he records time of completion, turns in copy of work-order request to leadman. The leadman checks completed work order for time and materials and signs it off. If necessary, he inspects the job, then hands signed copies over to foreman.

Foreman OK's completed work-order request and sends it to maintenance-records desk. All this information finally ends up in a report to management.

Spare parts. But esprit de corps depends on thoroughness — nothing must be left to chance. John Malloy plans never to be caught without the proper spare part; he wants his organization to have everything it needs on hand when tackling a job. Photo, below left, shows one example — a spare-parts man checking a part against the inventory list attached to the top of the Navy-style spare-parts box. Each part is listed on the inventory sheet and the corresponding number marked on the part or its container. As a part is used it is replaced in the proper box so it'll be there when needed again.

Our maintenance gets results

Speaking at the 12th Plant Maintenance & Engineering Conference, R E Snider, maintenance and construction superintendent for General Motors Corp's AC Spark Plug Div, listed steps GM follows for best maintenance results:

(1) Purchase quality equipment. To begin with, we go along with adopting the Joint Industrial Code of Electronic Standards. We feel there will be many improvements in this area in the next decade. We buy best-quality tubes—premium tubes for our automated equipment and power-supply units.

(2) Develop personnel who will improve on circuitry design. We give a good maintenance man a free hand. He then feels full responsibility and takes pride in his improvements. We pay awards for good work, too.

(3) Set up standards of good practice. Handy spare parts, for example, save time on repairs—the mechanic can make the repairs right at his bench. Studying the unit at the bench is also educational.

(4) Furnish good test equipment. Our 200 test instruments and meters are valuable troubleshooting aids. Testing during troubleshooting develops good men fast.

(5) Organize preventive maintenance. We put a pm number and a property-tag number on each piece of equipment. A master file and punched IBM card are set up for each piece of equipment. Cards are dated: for example, the 4th, 20th, 36th week of the year if schedule calls for a thrice-yearly check. To decide frequency of pm checks, we divide equipment into three categories. Automated or line-flow machinery gets most-frequent checks. Machinery running periodically needs less pm. If the job could move to other equipment without interfering with production, equipment rates lowest in pm priority.

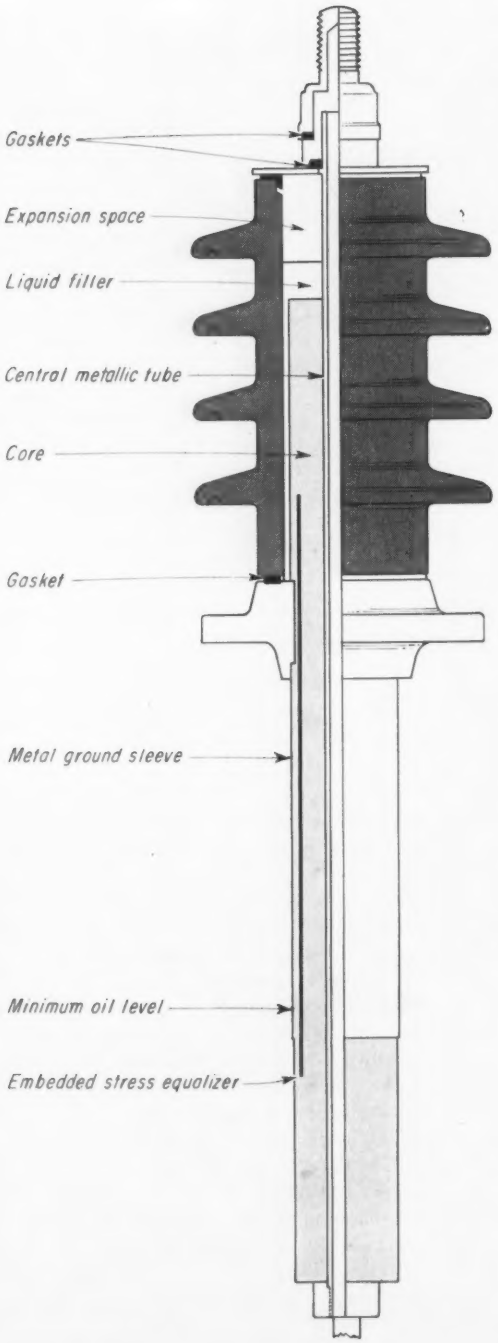
(6) Maintenance material. How can a man keep machinery running unless he has the proper replacement materials? Can construction men make new installations without proper materials? We call materials carried in stock *M&M*—minimum and maximum. We ask local suppliers to carry certain types in stock for us, too. All *M&M* items are reviewed by one man, who decides which category each item falls into, and has full responsibility for stocking.

Plant Electrical Fact File

No. 56: BUSHINGS

Tips on taking care of apparatus bushings

By NORMAN PEACH, Associate Editor



ushings on power transformers, oil circuit breakers and h-v instrument transformers are key equipment. On many installations you'll want to establish regular inspection and testing to learn which bushings may be deteriorating and threatening to become a cause of breakdown. If any such bushings are found, you can usually replace them before they cause trouble.

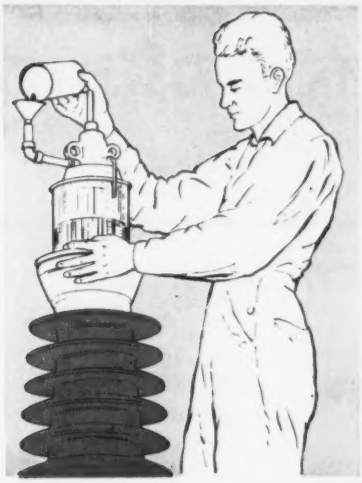
Frequency of inspection and testing depends on (1) construction, condition and age of bushings (2) operating conditions such as unusual overvoltage or dirt (3) importance of service continuity (4) bushing accessibility (5) availability of maintenance personnel and facilities.

Don't undertake repairs to insides of a bushing; this requires special equipment and skills not generally available away from the manufacturer's plant. If you find internal trouble, return bushing to maker.

CONSTRUCTION of typical 34.5-kv bushing shows essential parts. Designs differ according to maker and voltage: higher voltages require more-exacting designs. Bushings are filled with insulating liquid, usually oil, though some types have solid insulating filler compound instead

CLEAN BUSHINGS when dirt accumulates on insulators to extent where flashover threatens. A cloth wet with benzene or ammonia is usually effective; more-stubborn dirt may require bushing cleansing powder. For extremely bad conditions use dilute hydrochloric acid—but not more than 1 part HCl to 40 parts H_2O. Neutralize the HCl with bicarbonate solution

REPAIR INSULATORS by smoothing chipped edges with abrasive stone. Knock off chips likely to fall later. Paint smoothed porcelain with compound which provides still smoother surface. Significance of crack or chip depends on its configuration—crack which appears to extend into body of porcelain should be examined; if it's deeper than glaze hazard may exist

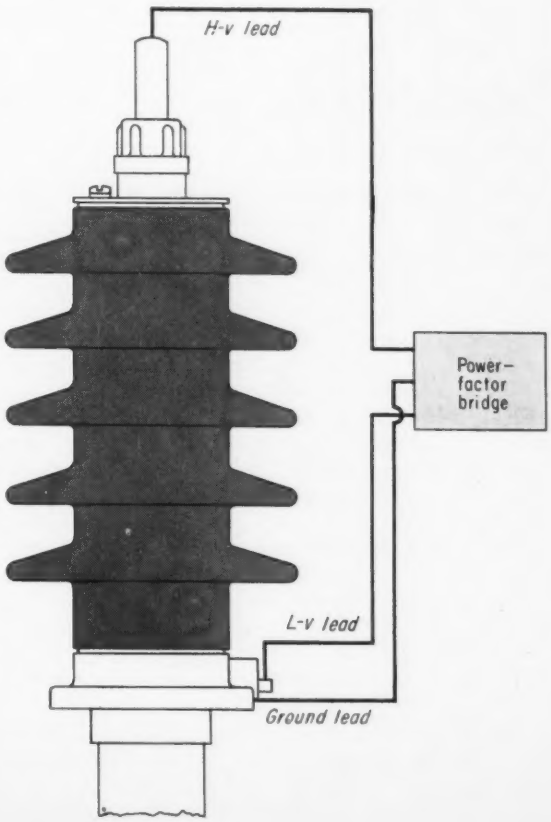


FILLER LEVEL is indicated by gage glass or pointer gage. Fluctuation in readings can be expected because of expansion and contraction of the liquid, but sudden loss of filler or continuing drop in level is sign of trouble. Familiarize yourself with normal operation of each manufacturer's gage so you'll spot abnormal conditions, prevent bushing failure

POWER-FACTOR TESTING is probably best way to detect moisture in a bushing. Pf in sealed bushings is low initially and stays low if bushing is in good condition. Increasing pf means bushing's dielectric is changing and may deteriorate dangerously. Bushings are a sort of capacitor and are provided with a capacitance (low-voltage) tap.

Details on equipment and how to make tests can be obtained from manufacturers' instruction books or American Society of Testing Materials publication D150-47T. There are a number of reliable pf-testing bridges available from 110 v to 10 kv. Tests are made by *ungrounded-* and *grounded-specimen* methods. Ungrounded is preferable, where possible, because pf readings aren't appreciably affected by conditions outside bushing. Some types of bushings are designed so ungrounded-specimen tests can be made without removing bushing from apparatus. One way this is done is to insulate the bushing from the apparatus cover by a gasket and insulated bolts. Normal grounding is provided by one uninsulated bolt which can be removed when testing.

Large variations in temperature may have an important effect on p-f readings, so record temperature measured by thermometer in contact with porcelain. For comparison, always take readings at about same bushing temperature



These **plant problems** could well be yours...

Problem . . . How do I stop soot, ash damage?

We have two watertube boilers of 30,000 and 40,000 lb-per-hr capacity respectively supplying steam for our dyeing and finishing plant. We fire Bunker-C fuel oil containing about 4% sulfur.

Our problem centers around soot-blowing operations for the two boilers. During each soot-blowing cycle, ash and soot from our stack filter back through plant windows and doors, causing great damage to material in production or stored in the plant.

We regulate our air-fuel ratio to supply about 18% excess air during normal operation, resulting in perfectly clean stack conditions. Plant construction would make sealing doors and windows prohibitive. Could readers suggest a simple solution to our soot problem?
—*DR, December* POWER

Solutions...

Reduce soot-blowing frequency

DR's soot problem is not unusual, but he can at least minimize and probably eliminate it by taking three time-tested corrective steps:

(1) The combustion products of sulfur are predominantly gaseous and therefore the high-sulfur Bunker C he burns should produce little ash if his oil burners are operating properly without carbon loss. It shouldn't be necessary to run at 18% excess air to produce a clear stack. Therefore, he should review atomization at his burners, adequate mixing of air and oil in his furnace and tightness of his boiler settings, all toward assuring that no carbonaceous materials are produced in his furnace.

(2) Reduced amount of solids then produced can be dissipated into the atmosphere by installing at the top of the stack an orifice designed to give a release velocity of approximately 6000 fpm at full flue-gas flow. This velocity will "loft" particulate matter into the air where it will not fall in the vicinity of the plant. If necessary, drafting apparatus should be operated at full load during soot-blowing to provide the air necessary to effectively dissipate dust into upper air currents.

(3) While it is a worthy objective to clean boilers regularly, it is frequently the better part of valor to refrain from operating soot blowers when there is no wind or when there is an atmospheric-inversion problem that tends to prevent dissipation of stack discharge. The average boiler will suffer nothing more than a minute loss of efficiency if permitted to run hours or even days beyond its normal soot-blowing time, and orders should be issued to refrain from soot-blowing except under conditions of favorable wind direction and velocity.

F G FEELEY JR, *Larchmont, N.Y.*

Try additives in fuel and furnace

Let us start in with the fuel-oil tanks. I believe an additive in the tank might be of some help; then a small hand blower could be used to force a soot-removing chemical powder into the furnace. The positions of burners and impellers should be checked. The furnace should next be examined for missing baffles etc, soot-blower heads repaired or replaced if worn. A complete cleaning of the

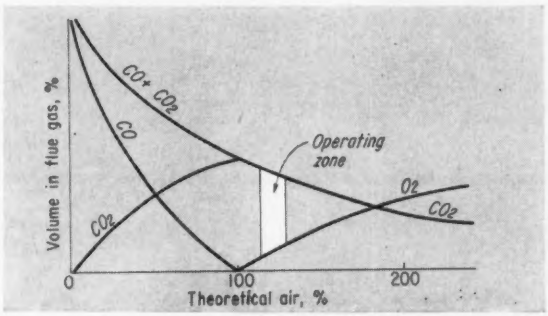
...Here's how Power readers would tackle them

LAWSON STEWART, Associate Editor

furnace (including external tube washing with hot water), uptakes, breechings and base of the stack is next. Then systematic operation of the soot blowers should solve the problem of heavy discharge from the stack.

If this fails, the solution is to cut into the breeching before it enters the stack and install a flyash collector with hopper, vacuum line with steam-jet air ejector and storage silo. Then *DR* can start the vacuum system on the hopper and run it while he blows tubes. This positive solution is widely used.

J KING, *Brighton, Mass.*

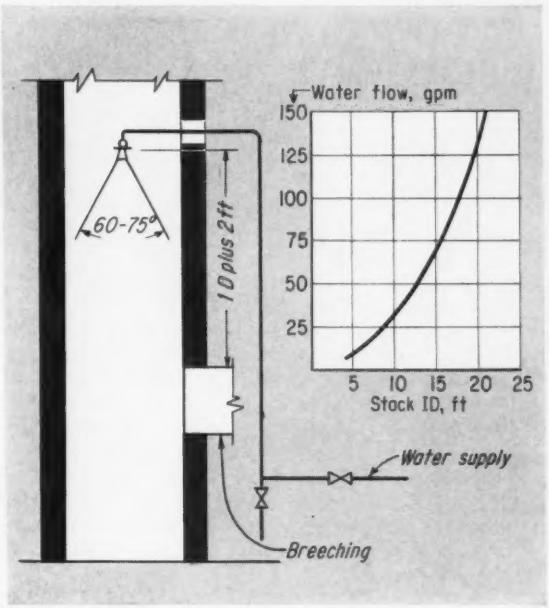


You may have combustion problems

The word "soot" generally refers to combustion products. However, if the Webster definition of "finely divided particles of carbon" is applied it follows that combustion is not complete. If *DR*'s problem is unburned-carbon residue and not a rock-like cornflake deposit he may find that he is using too much air, cooling the fuel-air mixture and resulting in incomplete burning. Unburned-carbon products readily deposit on the relatively cool surfaces.

Assuming steady firing conditions have been satisfactory, soot deposits may be accumulating during startup or on load changes when excess air is not closely regulated. It seems that adjusting air to produce a "clean" stack just above the point of darkening would be preferred to the chance of having too much excess air at 18%. Of course O_2 or CO_2 readings would be advantageous once the furnace requirements were determined. A plot of products of combustion with varying amounts of air for the fuel oil being burned is a handy guide. Very likely, *DR* is having extensive boiler damage because of the formation of sulfur compounds with a 4%-sulfur oil.

M L MYERS, *Concord, Tenn.*



Install stack-gas spray washer

One method available for limiting soot release during blowing operations employs a spray located inside the stack. Sketch, above left, shows details.

This facility allows 50 to 70% of soot to collect in the base of the stack. Collection efficiency is influenced by water flow rate. Approximately 0.40 gpm per sq ft of stack area offers optimum results. Plot, above right, shows total water flow as a function of stack diameter.

Effective soot control calls for water at nearly constant pressure and flow rate. A nozzle with spray angle of 60 to 75 deg will do an effective job.

For best results, the spray should be operated only during soot-blowing periods. To prevent possible stack damage resulting from excessive water quantities blowers should be operated frequently for short periods. This procedure will also avoid need for removing large amounts of water that accumulate in the stack base. During operation, the spray should be turned on before start of soot-blowing and turned off after blowing is completed. Automatic control offers greater assurance that spray water will be available during the blowing cycle.

H B WAYNE, *Woodhaven, N.Y.*

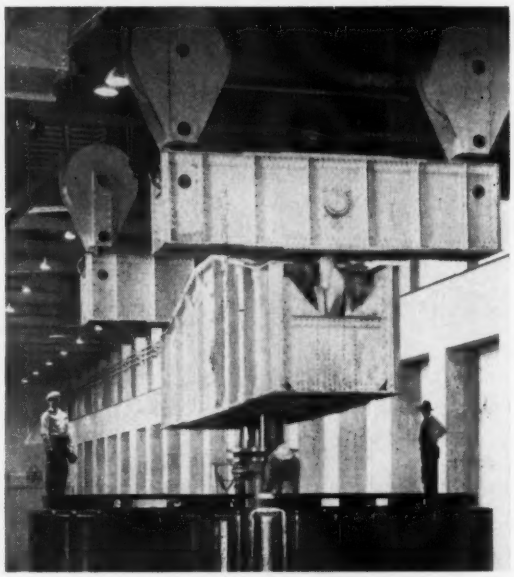
Want some help on plant problems? Send your design or operating headaches in for Power reader comment

Problem . . .

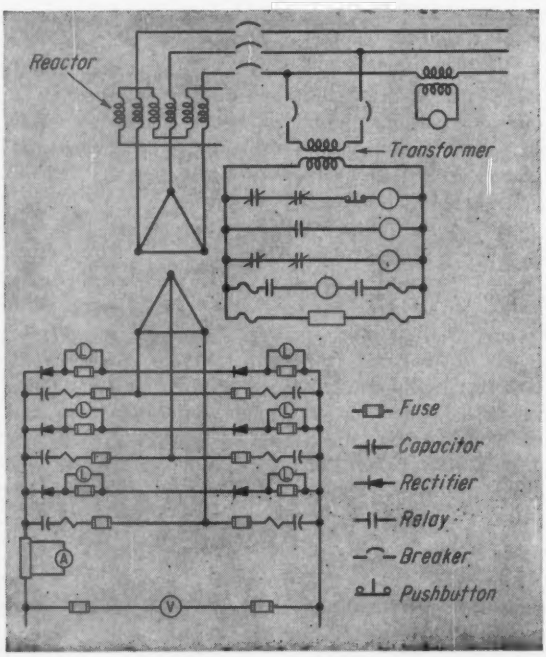
What power supply for cranes?

Our two 5-ton traveling cranes are due for thorough overhaul. Motors operate on 230-v dc supplied by m-g sets. Dynamic braking is provided for lowering. M-g sets are old and probably need rewinding since insulation is brittle. We have been considering replacing them with silicon rectifiers. What has been readers' experience with silicon rectifiers for crane duty? We installed them on a freight elevator about a year ago and performance has been good.

Can silicon rectifiers be paralleled with m-g sets for this kind of duty? Motors of our m-g sets are supplied with 440-v 3-phase ac. But actual terminal voltage is closer to 450. Nominal 220 v is available but voltage on our ac system tends to be a little above that. Will this cause rectifier difficulties?—*REH, December* POWER



Solutions . . .



Silicon rectifiers can do your job

Silicon rectifiers have been used successfully as dc power supply for cranes, elevators and similar applications. Conversion efficiencies range between 92 and 95% at full load, with voltage regulation limited to about 8%.

At continuous load, operation at 100% capacity is unlimited. With cranes subject to momentary peaks, 200% overloads for one minute following 100% load may be accepted without operating difficulties.

Usual hookup includes an ac breaker which also is available for protecting the dc circuit. An alternate arrangement has an additional breaker in the dc circuit. Sketch, left, is an elementary diagram showing a typical arrangement in use today.

Dynamic braking, attendant on many lifting services, may be employed by use of a resistor which absorbs the regeneration energy. A value of 6 to 10% of the rectifier rating is usually sufficient.

Potential variation with silicon rectifiers is usually low enough to eliminate need for an automatic voltage regulator. However, if this feature is required it may be con-

nected in the ac supply circuit to provide constant dc voltage regulation for the system.

Silicon rectifiers may be paralleled with each other and/or with motor-generator sets. With these arrangements both ac and dc breakers should be installed. This will protect against faults occurring inside the rectifier and prevent power interruption to other units.

Rectifiers having the same voltage and kilowatt rating may be connected to the same dc bus. However, comparison of rectifier and machine characteristics is necessary to determine if proper load division may be had throughout the operating range. Number of units that may be operated in parallel is influenced by their size.

H B WAYNE, *Woodhaven, N.Y.*

Hang on to your m-g sets

Rectifiers are excellent for converting ac to dc for many power applications and can be stacked to meet most voltage conditions. But when they are exposed to dynamic braking loads extreme care must be used in applying them. Only a few months ago two engineers from two of the leading elevator manufacturers published strong and opposing views regarding the use of rectifiers to provide dc for elevators—the chief bone of contention being dynamic braking. When experts disagree one must examine his problem more carefully.

Cranes are exposed to rougher handling than elevators. Dynamic braking is sometimes applied very suddenly, generating voltage which could far exceed a rectifier's peak inverse voltage unless the rectifier's circuit was designed with a high safety factor to handle the peaks—and this greatly increases system cost.

Although some rectifiers have been successfully paralleled with motor-generators it might be asking for trouble to do this with a crane's circuitry. Even so the output voltages would have to be carefully regulated to prevent one or the other from carrying too much of the load. I would give some consideration to using rectifiers in the exciter circuitry of a motor-generator. The inherent inductance of the field coils should adequately filter the ripple in the rectifier's output.

All in all, if I were *REH* I would hang on to my motor-generator sets. They've proved their reliability in the past and his service crew knows how to maintain them. The new types of high-temperature wire insulation on his rewound m-g sets will enable them to take overloads and voltage surges far more easily than they have when the insulation was of the older type.

J BELUNAS, *Wyoming, Pa.*

Your March problems

Can we prevent exhaust-vent icing?

We operate a medium-sized dyeing and finishing plant recently opened in the New England area. Our plant includes several bays of dyeing vats producing moisture and fumes. To exhaust this saturated air we have a number of fans mounted below the roof and exhausting through louvered outlets in penthouses. In winter months we pull air through a series of duct openings which include steam-coil heaters. Air passes through finishing rooms and into the dyeing bays. Between the high temperature of this air entering the dyeing bays and the large amount of vapor put out by the vats, exhaust air is loaded with moisture.

Our problem arises when the outside temperature drops near 0 F. On those days exhaust air is chilled as it leaves the penthouse louvers to the point of not only condensation but crystallization. Heavy ice deposits build up on our louvers, blocking the openings and eventually cutting down on cfm exhausted by our roof fans. Short of chipping or steam-cutting ice off we have not been able to solve our problem. Can some reader suggest a permanent solution?—***DTP***

How to measure well temperatures?

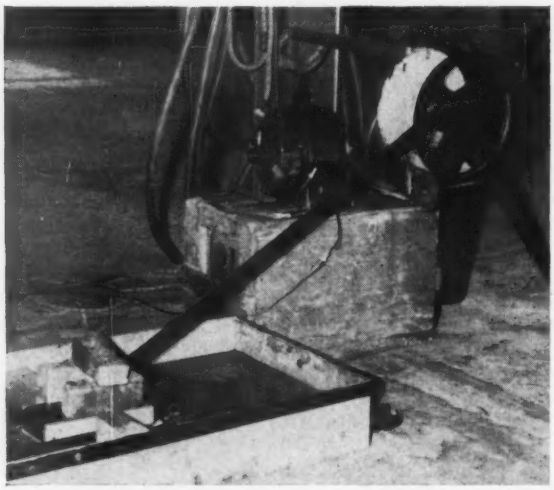
In our business, producing steam from geothermal sources, we must measure temperatures in our wells at depths which may be up to 2000 ft. These temperatures can be as high as 500 F and vary independently of depth, although the overall trend usually rises as depth increases. Some wells are full of water. We must measure well temperatures immediately after drilling to observe cold spots and then watch them heat up—zones that heat up most rapidly will produce the most steam, so theory has it.

We have used three different instruments without complete satisfaction. First, a maximum-indicating thermometer which once it reaches a maximum at any point cannot indicate lower temperatures at another point in the well. We also used teflon-coated thermocouple wire, but teflon coatings are not always waterproof in our service. We tried a clock-mechanism recorder but found the timing undependable under high-temperature operation.

Possibly some reader has a solution.—***WMM***

Sit down right now and answer one or both problems. We'll pay extra for answers with photos or sketches

Timely **practical ideas** to help solve



Homemade abrasion tester gives samples a hard time

In the hydroelectric field there are many materials used as liners on water-lubricated guide bearings. In the past, lignum vitae and rubber were most common, but the war put these materials at a premium. Then a number of synthetic compositions came on the market, some of them comparable to lignum vitae, others to rubber.

Main requisite of a water-lubricated bearing liner: withstand wear caused by the continual action of abrasive river-water particles that get through the screens.

To determine the wearing qualities of these new materials we made a somewhat crude contraption, photo. Rig consists of a reciprocating arm driven through a speed reducer by a ½-hp motor. Sample under test was fastened to a block. While it was immersed in water we let it rub back and forth against a steel plate, simulating actual working conditions. A counter (not shown) was later installed so we could keep an exact record of strokes. The bricks on top of piece being tested in photo are for loading only.

This is an accelerated and perhaps somewhat severe method of testing liner materials. By measuring the wear we could determine the superior material after only a few days.

W BUCKSHEE, *Shawinigan S, P.Q.*

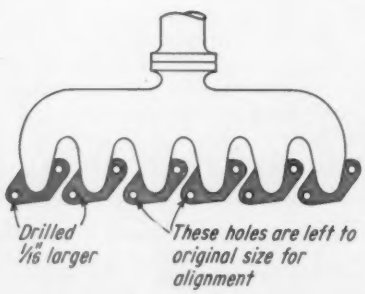
Check lifting gear

J A Fuller's incident involving top half of a turbine casing (*Practical Ideas*, Nov 1960, p 217) was interesting. I was once an insurance-company inspecting engineer. Assigned to a 1-man territory, I acquired a broad experience in safety work.

One of our clients, a paper mill, was making an annual inspection and overhaul of a 1500-kw turbine. Manufacturer's service engineer was supervising the job but I was present because breakdown insurance covered use and occupancy as well as direct damage in that plant.

We had completed the internal inspection and were lowering the cover into place. With seven in. to go, the serviceman borrowed my flashlight and was about to reach under the cover with it. I picked up a piece of 2 x 6 block and shoved it in alongside his hand. When he withdrew his hand I pulled out the block. Suddenly, with no one touching anything, the load chain of the geared chain fall slipped two links.

I was congratulating myself for being a wide-awake safety man and possibly having saved a man's hand. Then I realized that I had neglected to look over the load chain and the load-chain sprocket. The corners of the load-chain links were worn away some 15 to 20%. Sprockets were just as bad and ready to give way.



Let your manifold creep so it won't crack

We repair-welded the cracked cast-iron exhaust manifolds of our automotive-diesel engines. These engines are used in our plant for driving portable air compressors. But trouble was, we'd eliminate the failures at the manifolds and engines would crack again at some other place.

An examination revealed that the failures were caused by too-snug flange stud holes. They restrained normal heat expansion at high temperatures.

To solve problem, we drilled stud holes of the four outermost flanges 1/16-in. larger in diameter, sketch. That gives the manifolds a chance to creep, especially at both ends, ending the annoying cracking problem.

E WITTMAN, *Villas, N. J.*

your tricky design and maintenance problems

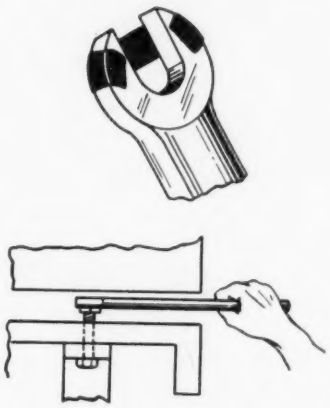
STEVE ELONKA, Associate Editor

before the big hoist

A few inquiries around the plant disclosed that the chain hoist had been used for many years on the paper-machine floor, handling heavy press rolls and dryer cylinders. It had then been given to the bull gang. The building was old mill construction; a fork-lift truck passing above caused enough vibration to trigger the slippage of that cover.

The serviceman normally knew better than to reach under a suspended load but he had blotted up a few boilermakers at the hotel bar the previous evening. Some rust was still in his think box. The turbine wheels weren't damaged because the weight had fallen such a short distance. I learned my lesson: a safety engineer tries to outguess the accident—and sometimes he succeeds.

F GILLMOR, *Albany, N. Y.*



What would you have done?

I was assigned as second assistant engineer to a new Army mine planter in 1942. The ship had two sectional header boilers, Todd burners, two electrically driven gear type fuel-oil pumps, combustion controls, forced-draft fans, usual pressure gages and a pyrometer with selector switch for port or starboard boiler-stack temperatures.

Finally we sailed but the undiscovered "bugs" kept us busy. One day when it seemed that nothing else could happen, I was awakened by the general alarm. Hurrying below I found the first assistant starting the firepump. He shouted that flames and heavy smoke were belching from the stack.

In the boiler room all appeared normal, so I switched the port boiler and found the stack temperature off scale at 1200 F plus. The starboard boiler indicated a normal 625 F. I pulled the fires on the port boiler and went up through the fidley to watch the fire die out. But there was bedlam on deck. Fire hoses were turned on as I scooted below. The flames and smoke from the stack were terrifying.

I quickly lit off the port boiler and pulled the fires from the starboard boiler. As I did so, the fuel-oil pressure gage climbed rapidly. The pointer jumped the stop pin and went part way around again. At this cockeyed performance, I glanced at the fuel-oil pumps. They were both running. I tripped one pump. The FO pressure gage came down toward normal but didn't get by the stop pin so it read zero. I turned my back on this and phoned the bridge for a report on the fire. "Fire is out."

Our trouble had been from failures of watch fireman to properly secure the burner tip on a clean burner he inserted into the starboard boiler. The tip wore off after some time. When it did the fuel-oil pressure took a sudden drop from 600 to about 350 psig. The fireman called the first assistant and the two of them started the second fuel-oil pump.

The pyrometer should have indicated the culprit boiler but the leads were cross connected, port indication reading, starboard stack temperature and vice versa. I guess it takes years to discover most of the "bugs" in a new plant. In this situation, what would you have done?

H W MOORE JR, *Trumansburg, N. Y.*

Masking tape helps replace nut in tight places

We had to replace a nut in a tight spot where it was impossible to start the nut with our fingers—just no space, sketch. So we stretched painters' masking tape tightly across the wrench opening on one side, wrapped it around edges. Nut was then put in the wrench opening and pressed firmly against the tape. This idea works well in removing nuts, too, and keeps them from falling into parts of the machine. Tape has saved us a lot of time.

L KASPER, *Philadelphia, Pa.*

Did you know . . .

that a new library, *Standard Plant Operator's Q & A*, has just been published by the McGraw-Hill Book Co? It has 20 chapters, covers everything from the Boiler Code to operating nuclear plants to latest gas turbines. Comes in two volumes.

ONE OF A SERIES OF CHATS ABOUT CONSERVATION AND CONTROL OF HEAT

SARCO TOPICS

MODERNIZING A STEAM SYSTEM MEANS TRAPPING, TOO

Take an older building that has generated its own steam for decades and let's say it's switching to district steam. How can it take advantage of switch-over to rid itself of those classic symptoms of antiquated systems: trap maintenance at overtime rates, water-hammer, and live steam loss?

Well it just so happens a 17-story office building at 635 Madison Avenue, New York, recently did just that. Its steam system was overhauled; but recovery is now complete and it didn't hurt a bit.

First, let's look at the system as it was: Maintenance of the old system had to be done at overtime rates in off hours, because the system could not be shut down during business hours. There were frequent breakdowns. Passage of live steam into return lines when traps failed open not only wasted energy but caused water hammer, and when traps failed closed, water accumulated in steam supply mains and equipment.

The reason we give you this dreary picture is that it's so typical of old systems, and so easily fixed. The building management simply replaced bucket and float traps with Sarco Thermo-Dynamic Steam Traps, Type TD-50, matched and correctly sized to the application. And at the risk of sounding like a TV commercial, results were immediate: maintenance practically

zero, no water hammer, no loss of live steam, engine room crew free for other jobs. And, need we add, considerable savings.

We find it difficult to be modest about the TD-50 because it comes so close to being a cure-all. The facts are these: It has only one moving part, a stainless steel disc; it shuts off *positively*, so no steam can be lost; it discharges condensate as rapidly as it is formed; its pressure range of 10-600 psi makes it possible to standardize on one steam trap for a variety of applications that formerly required traps of many types and ratings.

Funny thing is, the TD-50 is so dog-gone *simple* and *small*, people find it hard to believe it does what it does. At 635 Madison Avenue, for example, changeover took only 30 minutes per trap, and trapping was accomplished with a few pounds and cubic inches of traps where hundreds of bulky pounds were needed before to do the job.

Write us for details, won't you? You've nothing to lose but your troubles, your waterhammer, and your worries.

HEATING COILS CAN CATCH COLD

Let's face it: even the best "non-freeze" air heating coils may freeze if they handle incoming air even slightly under 32°F. and aren't drained properly. Let's face it again: It's *not* inadequate steam trapping capacity that's most usually to blame. We don't mean to belabor the point, but if trap inlet pressure falls lower than trap outlet pressure, condensate *is* going to collect in the coil. And it's *bound* to freeze below 32°F. Take a preheat coil designed to heat air from 0°F. to 50°F. using steam at a maximum pressure of 10 psig. As the outside air temperature rises above 0°F. heat demand decreases the temperature controller reduces the steam pressure to compensate fo reduced heat demand, and you're ripe for ice cubes in your coil tubes.

At Sarco we firmly believe that practical help is much more useful than sympathy noises. We can tell you (if it happens to be *you* who are caught with your temperature down) of at least three cures for fatal drop in pressure differential. They're quite simple and we would show not the slightest hesitation about revealing them to you.

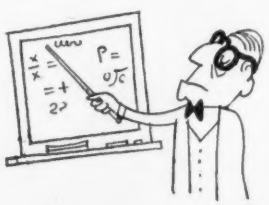
In fact, we'd also like to send you a master chart that enables you to check at a glance the danger point in handling outside air—an extremely useful piece of information—and a bulletin on Float-thermostatic steam traps.

It may hasten matters if, when you request this bundle of facts, you refer to the literature as Sarco Technical Bulletin No. T503.

MORE THAN ONE WAY TO TRAP STEAM

Just as there's no universal trapping application, there's no universal steam trap. The fact is that there are five basic steam traps in use today—and they're all rather thoroughly described in a rare monograph by Sarco engineers titled modestly and succinctly enough: Lecture 1A. You, personally, may not need a copy of this fundamental document, but wouldn't you like to know that your own people were up to date on steam trap basics?

It's easy to be sure this vital information gets into their hands: simply request a quantity of Lecture 1A and distribute copies as needed, with a little subtle persuasion that they be read. We can even arrange for a personal slide film lecture, followed by authoritative answers to trapping questions, if you can get an in-plant group together.



In any event, write to us. You may discover that a lot of progress is being made that isn't concerned with getting men to the moon.

Pardon our monopolizing the conversation in this series of paid communiques, but we're trying our best to interest you in certain subjects that concern us both—to the point where you'll communicate.

5108

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Power engineer—age 50—3 0years operation-maintenance and construction of steam plants and recovery boilers—some hydro and some diesel. Best of reference. PW-6069, Power.

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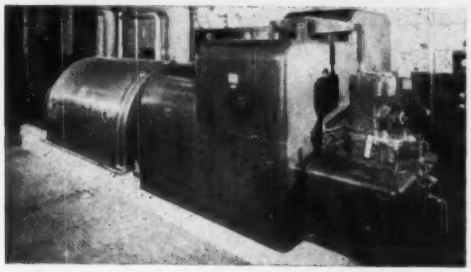

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750	El. Machy.	Synch.	480	514
700	G.E.	Slipring	2300	514
600	G.E.	Synch.	480	900
600	Elliott (2)	Sq. Cage	2300	900
500	Al. Ch. 3 brg.	Slipring	440	514
500	G.E. b.b. (2)	Synch.	2300/440	1200
450	Allis Ch.	Sq. Cage	2300/440	720
400	Whse.	Sq. Cage	2300	514
400	Marathon (2)	Sq. Cage	2300	3600
400	G.E.	Slipring	2200/440	600
400	El. Machy.	Synch.	2300/4000	400
400	Whse.	Sq. Cage	440	1200
350	G.E.	Slipring	440	900
350	El. Machy.	Synch.	2300	900
300	G.E.	Slipring	220/440	514
250	G.E.	Sq. Cage	440	1200
250	Gen. Elec.	Sq. Cage	440	3600
250	Whse.	Sq. Cage	2300/440	600
250	Whse. (4)	Slipring	2300/440	600
200	Gen. Elec.	Synch.	550/440	400
200	G.E. b.b.	Sq. Cage	220/440	720
200	G.E.	Slipring	220/440	450
200	G.E.	Slipring	440	600
200	G.E.	Slipring	2200	900
200	Reliance b.b.	Sq. Cage	220/440	1800
200	Allis Ch.	Slipring	2200/440	720
200	A.C. TEFC	Sq. Cage	220/440	1200
150	Whse. b.b.	Sq. Cage	440	1800
150	Cr. Wheeler	Sq. Cage	440	450
150	Whse. XP	Sq. Cage	440	3600
150	G.E. (4)	Slipring	2200/440	600
150	Whse.	Slipring	220/440	1200
125	Whse. b.b.	Sq. Cage	220/440	900
125	A.C. TEFC	Sq. Cage	220/440	1800
125	El. Machy. (2)	Synch.	220/440	400
125	G.E. TEFC	Sq. Cage	2200	3600
125	Al. Ch. TEFC	Sq. Cage	220/440	600
125	G.E. (2)	Slipring	220/440	514
125	G.E.	Sq. Cage	2300/440	1200
100	Allis Ch.	Slipring	2300/440	600
100	Al. Ch. TEFC	Sq. Cage	2200	1800
100	G.E. b.b.	Sq. Cage	220/440	3600
100	G.E. (2)	Slipring	220/440	1200

D. C. GENERATORS

KW	Mfr.	Type	Volts	Speed
300	Gen. Elec.	CY-221	250/350	1200
200	Gen. Elec.	RC	250	1450
100	Delco b.b.	late	120/240	1200
75	Allis Ch. b.b.	EB-146L	125	1500
60	G.E. b.b.	CD	600	1750
50	G.E. (2)	CD-112D	250	1200

D. C. MOTORS

HP	Mfr.	Type	Volts	Speed
250	Cr. Wh.	101-H	250	1150
200	Whse. b.b.	SK	250	287/575
150	Rel. TEFC b.b.	2550-F	230	850
150	Whse.	SK-210	230	320/1000
125/150	F.M. b.b.	DXZD	230	325/1300
125	G.E.	CD-173	230	575/1150
100	Elliott b.b. T.E.	JH-FE	230	1150
100	El. Dyn. b.b. (2)	30-8	230	450/1200
100	G.E. crane	CO-1831	230	575
75/100	Whse.	SK-191	230	300/900
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200	Gen. Elec.*	220/440 AC	125 DC
125	Whse.	220/440 AC	250 DC
100	Delco b.b.	220/440 AC	120/240 DC
80	Star b.b. Synch	220/440 AC	250 DC
75	Whse. Synch.	220/440 AC	250 DC
60	Ideal	220/440 AC	125 DC
50	G.E.	220/440 AC	250 DC
30	G.E. (2)	220/440 AC	125 DC
30	Whse.	220/440 AC	250 DC

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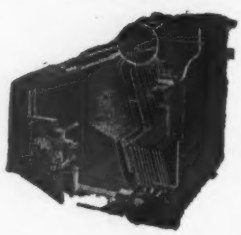

# Steam/hr.	Key	PSI	Temp.
122,500	DF	565	850
121,650	DF	565	850
60,000	SF	435	750
74,000	H	280	500
55,000	A	240	—

DF Double Furnace, SF Single Furnace (illustrated), bent water tube boilers w/economizers and superheaters, B & W's and Foster Wheelers.

H Header type, straight tube, B & W.

A 3 drum, single furnace, Wickes.

Polnik-Loconti Industrial Supply, Inc.

315 Oriskany St., Yorkville, N.Y.

Utica, N. Y. Ph. RE 6-4621, RE 2-4513

Circle 508 on Reader Service Card

TURBO-GENERATOR

New — Unused — In Original Cases

G. E. 33,000 kw Turbine Generator

Preferred Standard — H2 Cooled, 13,800 V., 60 cycles.

ATTRACTIVELY PRICED

For Further Information—Contact

Ebasco International Corporation

100 Church St., New York 7, N. Y.

ATT. J. Forsyth

Circle 510 on Reader Service Card

BARGAINS!

1050 HP FAIRBANKS-MORSE DIESEL MODEL 32, 7 CYL., 257 RPM, 726 KW, FM 3/60/2400 WITH EXCITER, SWITCHBOARD, ETC. VERY LOW PRICE.

3000 CFM WORTHINGTON AIR COMPRESSOR 2 STAGE, HORIZONTAL, 164 RPM, 5 STAGE CONTROL. 650 HP 3/60/440 SYNCHRONOUS MOTOR. COMPLETE ACCESSORIES.

WHISLER EQUIPMENT CO.
1908 Railway Exchange Building
St. Louis 1, Mo.

Circle 514 on Reader Service Card

We own and offer Power generating equipment

1—1785 KVA vertical Skinner engine
1—1250 KVA West. condensing-extraction turbine
1—875 KVA horizontal Skinner engine
1—625 KVA Worthington non condensing turbine
1—715 KVA West. non condensing turbine
1—500 KVA G.E. non condensing

Steam coditions on above vary from 140 to 400 lbs. 750 degrees.

WHITE ELECTRIC MOTORS

LOWELL, MASS.

Circle 511 on Reader Service Card

COMPRESSORS

No better values at any price

100 CFM	150 PSI 6x7 Ing. ES-1
138 CFM	100 PSI 7x7 Ing. ES. CP & Joy
288 CFM	100 PSI 9x9 Ing. Worth. CP
294 CFM	125 PSI 9x9 Joy WG-9
321 CFM	125 PSI 10x11 Ing. ES-1
351 CFM	350 PSI 11-5x11 CP TCB-2
465 CFM	100 PSI 12x11-1R-ES-1" Chic. P.T.
502 CFM	125 PSI 12x13 Worth HB
593 CFM	125 PSI 13½-8½x8 Worth DC2
686 CFM	100 PSI 14x13 Ing. ES
800 CFM	100 PSI 14¼-9x7 Ing XLE 125 HP Syn. 3-60-2300
877 CFM	125 PSI 17-10½x14 1R. XRB
1290 CFM	125 PSI 13-8x7 Joy WN 114 E 200 HP 3-60-220 or 440 Volt
2520 CFM	125 PSI 17-10½x8 Clark, CMA4L 350 HP 3-60-2300 (1954)

AMERICAN AIR COMPRESSOR CORP.
48th & P, North Bergen, N.J. UN 5-1397

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AUTOMATIC and MANUAL
Gas or DIESEL GENERATOR UNITS

Complete Switchboard Design and Construction

USED & REBUILT EQUIPMENT

UNIVERSAL POWER ENGINEERING CO.
382 Wayne St. Jersey City, N. J.
Phone: DElaware 2-8300

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TRANSFORMERS
NEW • REBUILT

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P. O. BOX 51 • ROCHESTER 1, N. Y.

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HI-PRESSURE

Turbogenerators, Pumps, Fans.
One of Nation's largest inventory, New & Used

INDECK POWER EQUIPMENT CO.
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OR 5-7666

Circle 516 on Reader Service Card

RE-NU-BILT ELECTRICAL EQUIPMENT

53 YEARS SERVICE

MOTOR GENERATOR SETS

Qu.	KW	MAKE	RPM	AC VOLTS	DC VOLTS
2	4800	G.E.	450	2300/4600	250/300
1	2500	WHSE.	720	2300/4160	600
1	2100/2400	G.E.	450	2300/4600	250/300
2	1750/2100	G.E.	514	2300/4600	250/300
1	2000	G.E.	514	2300/4600	600/666
1	1500	G.E.	720	13200/6600	600
1	1500	Cr. Wh.	720	2300/4160	30/100
1	1250	WHSE.	720	2300/4000	600
1	1000	G.E.	900	2300/4000	600
1	1000	G.E.	900	6600/4000	260
1	1000	G.E.	720	2300/4000	275
1	500	G.E. Unused	1200	2300	300
1	500	G.E.	900	2300/4600	250
1	500	G.E.	900	440	250/125
1	350	G.E.	900	440/4160	125
2	300	G.E.	1200	2300	275
1	300	WHSE.	1200	2300/4160	600
1	200	G.E.	1200	2300/4160	250

FREQUENCY CHANGER SETS

Qu.	KW	MAKE	FREQ.	VOLTAGES
1	12500	WHSE.	60 To 25	13200-13200
1	5000	G.E.	60/50/60	1100-6600
1	2500	G.E.	60/24/60	2400-2400

3 PHASE 60 CYCLE MOTORS SLIP RING

	HP	MAKE	TYPE	VOLTS	SPEED
1	1750	G.E.	M-579BS	4800/2400	1800
1	800	G.E.	MT-428	2200	450
1	800	WHSE.	CW	550/2200	1776
1	600	WHSE.	CW-32D	440	1778
1	600	WHSE.	CW	440	850
1	550	WHSE.	CW	440	252
1	500	WHSE.	CW	2300	881
1	500	WHSE.	CW	550/2300	350
1	300	AL. CH.	ANY	2200	720
1	300	GEN. EL.	MTP-561	2200	1760

SQUIREL CAGE

3	1500	G.E.	K D.P.	2200	3580
1	1000	AL. CH.	ANW	2300	1180
1	550/275	WHSE.	CS-1115	2300	863/445
2	500	WHSE.	CSP-583H D.P.	440	3600
4	500	AL. CH.	ARW-D.P.	2300	3600

OUTDOOR G.E. METAL SWITCHGEAR 600 V. 3 POLE, A.C.B.

1—3000 AMP., AL-2-75, ELEC. OPER.
1—1000 AMP. AL-2-50, MANUAL
4— 800 AMP, AL-2-50 MANUAL
1— 400 AMP., AL-2-50 MANUAL
3—SPARE COMPARTMENTS

PUMPS — MOTOR DRIVEN

6—600 G.P.M. Gould, Figure 3360, 8 Stage, 2310 Ft. Head, 1000#, 3550 RPM, Each coupled to 500 HP 3-60-3550 RPM D.P. Sq. Cage Motor

2—WHSE, Type CSP-583H, 440 volt

4—Allis Type 2300 volt Magnetic Encl. Reduced Voltage Starters

BELYEA COMPANY, INC.
43 Howell St., Jersey City 6, N. J.
Phone: OL 3-3334—N.Y.C. RE 2-7150

Circle 517 on Reader Service Card

MISS POWER EQUIPMENT SAYS,
"For BIGGER SAVINGS and BETTER SERVICE, Get Our BARGAIN PRICES on Guaranteed NEW and REBUILT MOTORS"

SQUIRREL CAGE MOTORS NEW AND GUARANTEED

HP	Make	REBUILT	Type	Speed
500	G.E. S.B. Open		IK	1200
400	West. B.B. Drip	CSP-681		1800
400	L.A. B.B. Splash			1800
400	G.E. S.B. Open		IK	1200
400	West S.B. Open		CS	900
350	West. B.B. Drip	CS-22556H		1200
300	L.A. B.B. Splash	FX-146S		1800
300	G.E. S.B. Open		IK	1800
300	Reliance B.B. Drip	AA-6085		1200
300	G.E. S.B. Open		IK	900
300	Cont. B.B. Splash N-804			900
300	G.E. S.B. Open		IK	720
300	G.E. S.B. Open KT-561			720
300	G.E. S.B. Open		IK	600
250	G.E. S.B. Open		KT	1800
250	West. B.B. Splash CS-875			1800
250	G.E. S.B. Open		IK	1200
250	G.E. S.B. Open		IK	900
250	G.E. S.B. Open		IK	720
200	G.E. B.B. Drip K-6325			1800
200	West. S.S.B. Open	CS-855		1800
200	Cont. TEFCBB NF-743X			1200
200	West. S.B. Open		CS	1200
200	G.E. S.B. Open		IK-15	1200
200	G.E. S.B. Open		IK-15S	1200
200	G.E. S.B. Open 2200 v.		IK	1200
200	G.E. S.B. Open		IK	900
200	A.C. B.B. Open AR-826			1200
150	West. TEFCBB	CS-8120S		1800
150	G.E. S.B. Drip K-6324			1800
150	West. S.S.B. Open	CS-771-C		1800
150	Al. Chal. B.B. Open AR			1800
150	West. S.B. Open 2200V		CS	1800
150	L.A. B.B. Open		115	1200
150	West B.B. Splash CS-580			1200
150	West. B.B. Drip CS-772			1200
150	West. TEFCBB CS-775			1200
150	G.E. B.B. Open		KT	1200
150	G.E. B.B. Open KT-587			1200
150	Al. Chal. B.B. Open	AR-828		900
150	Cont. TEFCBB N-743-X			900
150	Al. Chal. TEFCBB	AZ		900
150	F.M. B.B. Open H-24A			900
150	G.E. S.B. Open		IK	900
150	G.E. S.B. Open		IK	720
125	G.E. TEFCBB		K	3600
125	Burke B.B. Open 440 Volt	N-505		3600
125	Reliance T.E.F.C. B.B.	AA-5084		1800
125	G.E. S.B. Open		IK	1800
125	G.E. B.B. Splash W-505			1800
125	Al. Chal. B.B. Open AR			1800
125	G.E. S.B. Open K1-533			1200
125	Century B.B. Drip			1200
125	G.E. B.B. Open		IK	1200
125	Ideal B.B. Open A-805			1200
125	F.M. B.B. Open		H	900
125	G.E. S.B. Open		IK	720
125	G.E. S.B. Open		IK	600
100	Al. Chal. T.E.F.C. B.B.	ARZ-823		3600
100	C.W. B.B. Open 2300 Volt	SC-445		3600
100	Reliance T.E.F.C.B.B. New	AA-445U		1800
100	G.E. S.B. Open	KT-343		1800
100	G.E. B.B. Open	K-504		1800
100	Cont. TEFCBB XP	NP-505		1800
100	Al. Chal. B.B. Drip	ARW-823		1800
100	G.E. S.B. Open	KT-347		1200
100	Ideal B.B. Drip New	A-584		1200
100	West. B.B. Open	CS-607		1200
100	West. S.S.B. Open	CS-754-C		900
100	Al. Chal. T.E.F.C. B.B. XP	23E8		900
100	F.M. B.B. Open	H20C		900
100	Al. Chal. B.B. Open	AR-823		900
100	F.M. B.B. Open		H	720
100	F.M. B.B. Open		H	600
75	G.E. B.B. Open	K-505		1200

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Motors, Control Equipment, AC and DC Generators, MG sets and transformers.
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LARGE LINE OF SLIP RING MOTORS & CONTROLS.

POWER EQUIPMENT CO.
8 CAIRN STREET • PHONE BEverly 5-1662 • P. O. BOX 534 • ROCHESTER 2, N. Y.

Circle 518 on Reader Service Card

DIESEL ENGINES

1 HEAVY DUTY NORDBERG

Type TSM—model 32118—1700 HP @ 180 RPM — 21½" x 29". Unit complete with all pumps and coolers. Can be used for generator drive, producing 2400 HP @ 225 RPM. Equal to new. Presently in Maritime Academy.

1 UNUSED G.M. 12-278A

1200 HP — 8¾" x 10½" — 12 cylinder — VEE type — 2 cycle — 750 RPM — left hand — serial 50428. Excellent unused and fully guaranteed late type engine.

THE BOSTON METALS CO.
313 E. Baltimore St., Baltimore 2, Md.
ELGIN 5-5050 — LEXINGTON 9-1900

Circle 519 on Reader Service Card

3—G.E. 1000 KVA transformers, 1Ø, 13800-460 V.
1—Otis elec. freight elevator, 5000# @ 75 FPM.
3—Wagner 500 KVA transformers, single phase, 66000-460 volt.
1—Raymond 50" 5-roller hi-side mill, dbl. whizzer separator.
1—Babcock & Wilcox #32E coal pulverizer, airswept, 75 Hr.
2—E. Keeler 200 HP water-tube boilers, 160 PSI, Stoker-fired.
1—Gardner-Denver air comp., 445 cpm @ 100#, 6 cyl., 2 stage.

PERRY EQUIP. CORP.
1422 N. Sixth St.
Philadelphia 22, Pa.
POplar 3-3505

Circle 520 on Reader Service Card

ELECTRICAL POWER EQUIPMENT

SQUIRREL CAGE MOTORS

3 ph. 60 cy. 220 or 440 volts
(*2200 volts or higher)

HP	RPM	MAKE	VOLTS	TYPE
1500	1800	Al.-Ch.	2300	Ventilated
1250	3600	Al.-Ch.	4000	DP/PF
800	600	West.	2300	CS-44
600	600	West.	2300	CS-12
500	1800	G.E.	2300	KT-565Y
500	1200	G.E.	2300	FT-567
350	3600	Cr.-Wh.	440	80-68
350	1200	West.	440	CS-22656H
200	900	West.	440	CS-874S
200	720	G.E.	440	KF-564S

SLIP RING MOTORS

3 ph 60 cy 220 or 440 volts

HP	RPM	MAKE	VOLTS	TYPE
1500	514	Al.-Ch.	2400	Mill
1000	1200	Al.-Ch.	4000	Any
1000	900	Al.-Ch.	2300	Any
600	1800	G.E.	4160	M-6345-S
500	1200	G.E.	440	M-6345-Z
500	900	G.E.	440	IM
350	1800	Al.-Ch.	2300	ARY
250	720	G.E.	4000	IM
200	720	G.E.	2300	MT-566

MOTOR GENERATOR SETS

KW	MAKE	MOTOR GENERATOR A.C.V.	D.C.V.
1750	G.E.	4160/2300	250/300
1000	West.	4160/2300	250
750	G.E.	4160/2300	250
600	G.E. (3 unit)	2300/440	125/250
500	G.E.	2300	250
400	Al.-Ch.	2300/440	125/250
250	G.E.	2300	250

Write for current complete stock lists on electrical power equipment you need or send your list of surplus and used equipment for our offer.

Phone CAnal 6-2900

50 YEARS 1910 - 1960 SERVICE TO INDUSTRY

CHICAGO Electric Co.
1320 W. CERMAK ROAD • CHICAGO 8, ILL.

Circle 521 on Reader Service Card

38 Years Dependable Service

SLIP RING MOTORS 3 Ph., 60 Cy.

H.P.	Volts	Make	Speed
500	4000/2300	G.E.	600
450	4000/2300	G.E.	1200
400	2300/440	G.E.	600
400	4000/2300	Whse.	720
300	4000/2300	G.E.	720
300	440	Whse.	3600
250	4000/2300	Al. Ch.	600
200	2300	G.E.	600
200	2200/440	G.E.	720
150	440/220	G.E.	1800
150	2200/440	Whse.	720
125	2300	G.E.	600

AC GENERATORS or SYN MOTORS, 60 Cy.

H.P.	Volts	Make	Type	R.P.M.
400	2300	G.E.	TS	1800
400	2200/440	G.E.	ATI	720
300	2200/440	G.E.	TS	1200
300	440	G.E.	TS	720
150	440/220	Whse.	G	1200
125	440/220	Whse.	HB	400

SQUIRREL CAGE MOTORS

500	2200/4000	Elliott	SC	1800
400	2300	G.E.	FT	3600
400	2300/4000	G.E.	K	1200
350	2300/4000	G.E.	SEDP	3600
350	2300/4000	G.E.	K	600
300(2)	2300	G.E.	FT	3600
300	2300/4000	L. Allis	FS	1800
300	2300/400	G.E.	KT	600
250	2300/4000	G.E.	K	720
250	2300/440	G.E.	K	1200
200	2200	G.E.	KT	1800
200	2200	Cont.	TEFC	3600
150	440	Whse.	X-pf.	3600
150	440/220	Cont'l.	X-pf.	1800
150	440/220	G.E.	TEFC	720
150	2200/440	G.E.	TEFC	3600
125	2200/440	G.E.	FT	1200
100	440	Whse.	TEFC	3600
100	440	Cont.	X-pf.	1800
100	2200	G.E.	FT	900
100	440	Al. Ch.	Spl-Pf.	900

CIRCUIT BREAKERS, 3 Pole

2—1600 Amp., G.E., AL-50, 600 V., Air
1—1600 Amp., G.E., AL-50, 600 V., outdoor
1—1200 Amp., Whse., P-124, 7.5 KV, manual
1—600 Amp., G.E., 15 KV, Sol. oper.
1— 600 Amp., Whse., 7.5 KV, outdoor, New.

D. C. MOTORS

H.P.	Volts	Make	Type	Speed
150	230	El. Dyn.	B/brg.	600
90	230	G.E.	CD	1750
50	230	G.E.(4)	CD	1150

MOTOR GENERATOR SETS

KW	Make	Input., AC	Motor Type	Output V., DC
300	Whse.	4150/400	Syn.	250/125
150	G.E.	440/220	Syn.	250
125	G.E.	440/220	Sq. Ca.	125
100	G.E.	2200/440	Syn.	250
65	G.E. B	2200/440	Sq. Ca.	250

TRANSFORMERS 60 Cy.

3—500 kva, Whse., 4160-240 V., 3 ph., Inerteen
3—500 kva, G.E., 13,800—240/480 V.
3—200 kva, Mol., 13,800—2300 V.
3—333 kva, G.E., 13,800—2400 V.
3—333 kva, G.E., 2400—240/120 V.
3—333 kva, Whse., 2400/4160Y—240/480 V.
1—300 kva, Whse., 4160—480 V., Dry, New
3—250 kva, Whse., 2400/4160Y—240/480 V.
3—200 kva, G.E., 2400—460V. Pyr.
3—200 kva, G.E., 13,800—480 V.
3—200 kva, G.E., 4156—480/240 V.
3—167 kva, Whse., 4156—480 V.
3—150 kva, Al. Ch., 2400—220 V.
3—150 kva, G.E., 13,200—2300 V.
1—150 kva, Whse., 4160—120/208Y V., 3 ph. Dry New
3—100 kva, Whse., 2400—240/480 V., Dry
3—100 kva, G.E. 2400—120/240 V., Pyr.

only partial listing

STEPHEN HALL & CO.
HARRY J. RICE, Pres.
625 ADAMS ST., HOBOKEN 2, N. J.

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TRANSFORMERS

BOUGHT · SOLD · RENTED
REWOUND · RE-DESIGNED
MANUFACTURED

Ask for our Stock List

For Sale

3—2500 KVA G-E 69000—2400/4160Y
3—2500 KVA G-E 69000—7200/12470Y
4—2500 KVA W-H 34500—2400/4800/11000
3—1500 KVA G-E 69000—2400/4160Y
3—1500 KVA G-E 69000—7200/12470Y
3—1000 KVA G-E 34500—7200/12470Y
3— 833 KVA W-H 43800—480

THE ELECTRIC SERVICE CO., 5322 Hetzel St., Cincinnati 27, Ohio
"America's Exclusive Independent Transformer Service Shop"

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BOILERS

From the unfinished Battle Cruiser "Hawaii"

Material installed completely and never used.

8 Babcock & Wilcox Watertube Boilers

Approximately 157,000 lbs/hour. Working pressure 600#—850° T.T.—Oil-fired—with all boiler trim. Units are complete with fuel oil burning equipment—feed water pumps—feed water heaters, etc. Units are in prime condition.

CAN BE LOADED AS A UNIT OR DISMANTLED AND SHIPPED IN SMALLER SECTIONS

THE BOSTON METALS CO.
313 E. Baltimore St., Baltimore 2, Md.
ELGIN 5-5050 — LEXINGTON 9-1900

Circle 524 on Reader Service Card

FOR SALE

1500 KW, 80% Power Factor, 3 phase, 60 cycle, 2300 volts, 3600 RPM, General Electric 5-stage noncondensing steam turbine generator unit, 375 PSIG, 700° FTT, 125# exhaust back pressure, complete with direct connected shaft exciter and switchgear. Excellent condition—available immediate delivery.

EUCLID ENGINEERING CORPORATION
909 National City East Sixth Building
Cleveland 14, Ohio

Circle 525 on Reader Service Card

MODERN POWER BOILERS

1—Babcock & Wilcox	—122,000#s/hr—	—250 psi
3—Combustion-Engineering	—110,000	—200 psi
1—Riley	—100,000	—456 psi
1—Babcock & Wilcox	—100,000	—450 psi
1—Babcock & Wilcox	— 90,000	—265 psi
1—Combustion-Engineering	— 75,000	—250 psi
1—Riley	— 70,000	—250 psi
2—Babcock & Wilcox	— 70,000	—450 psi
1—Riley	— 60,000	—290 psi
2—Combustion-Engineering	— 50,000	—250 psi
1—Babcock & Wilcox	— 45,000	—450 psi
1—Combustion-Engineering	— 40,000	—220 psi
1—Foster-Wheeler	— 40,000	—200 psi
1—Babcock & Wilcox	— 35,000	—800 psi
2—Riley	— 35,000	—250 psi
1—Babcock & Wilcox	— 27,500	—450 psi
2—Riley	— 19,000	—200 psi

MIDWEST BOILER & TURBINE CO.
WARNER NEW HAMPSHIRE PHONE 244

Circle 526 on Reader Service Card

BOILERS, TURBO GENERATORS
PUMPS, FANS and STEAM SPECIALTIES
One of Nations Largest Inventory
New and Used
WABASH POWER EQUIPMENT CO.
Staff of Professional Engineers
3300 West Peterson, Chicago 45, Ill.
IN 3-0303-04

Circle 532 on Reader Service Card

Searchlight Equipment Locating Service

No Cost or Obligation

This service is aimed at helping you, the reader of "SEARCHLIGHT", to locate Surplus new and used power equipment not currently advertised. This service is for USER-BUYERS only. How to use: Check the dealer ads to see if what you want is currently advertised. If not, send us the specifications of the equipment and/or components wanted on the coupon below, or on your own company letterhead to:

SEARCHLIGHT EQUIPMENT LOCATING SERVICE
Classified Advertising
c/o POWER
P.O. Box 12, N. Y. 36, N. Y.

Your requirements will be brought promptly to the attention of the equipment dealers advertising in this section. You will receive replies directly from them.

SEARCHLIGHT EQUIPMENT LOCATING SERVICE
Classified Advertising
c/o Power,
P.O. Box 12, N.Y. 36, N.Y.

Please help us to locate the following used equipment:

.....

.....

NAME .....

TITLE ..... COMPANY.....

STREET .....

CITY ..... ZONE..... STATE.....

3/60

MOTOR GENERATOR SETS

Q	KW	MAKE	D.C.	A.C.	RPM
2	750	G.E.	250	3/60	720
1	500	Elliott	125	3/60	720
2	300	G.E.	250	3/60	1200
1	150	West.	250	3/60	1200
1	100	Star	250	3/60	1200

STEAM- TURBO- GENERATORS 3/60

Q	KW	MAKE	TYPE	I.S.P.	YEAR
1	10000	West.	Cond.	275	1932
1	7500	G.E.	Cond.	275	1948
2	7500	West.	Cond.	400	1945
1	5000	West.	Cond.	400	1938
1	5000	West.	N. Cond.	850	1941
1	3000	G.E.	Cond.	400	1940
1	2500	G.E.	N. Cond.	180	—
1	2000	G.E.	N. Cond.	180	—
1	1000	Elliott	N. Cond.	325	1930
2	1000	Elliott	Cond.	150	1949
2	300	G.E.	Cond.	400	1945

PACKAGE BOILERS

Q	HP	MAKE	W.P.	FIRING	YEAR
1	400	Cl. Bk	150	#6	1948
1	400	T'Ville	150	#6	1948
1	200	Erie	180	#6	1951
1	150	Cyclotherm	150	#6	1947
1	150	Cl. Bk	15	#6	1956
1	90	Cyclotherm	125	#2	1945
1	80	Cl. Bk	125	#6	1948
1	70	Ames	15	#2	1951
1	60	Cyclotherm	125	#2	1945

DIESEL GENERATOR SETS

Q	KW	MAKE	VOLTS	RPM
2	2000	Baldwin	230V.D.C.	257
2	1122	F.M.	400V.D.C.	720
2	1000	G.M.	3/60/2400	720
1	620	Alco	240V.D.C.	700
1	400	Worth.	3/60/480	600
1	300	G.M.	3/60/220-440	1200
2	125	Worth.	3/60/480	600

AIR COMPRESSORS

CFM	PSI	MAKE	TYPE	H.P.	VOLTAGE	RPM	YEAR
7550 (2)	24/30	I.R.	XHE	600	3/60/4160	300	1948
6000	125	Sullivan	H	1250	3/60/2300	200	1943
1853	125	Worth.	DC-2	300	3/60/2300	277	1946
1530	125	Worth.	OXP	250	Steam	200	1943
1308	125	C.P.	OCE	225	3/60/440	257	1937
1300	125	I.R.	XRE	235	3/60/440	257	1940
570	125	Gardner	WBK	150	3/60/440	870	1951
515 (4)	125	I.R.	40	100	3/60/440	870	1940/50
500	125	I.R.	K500		Diesel Portable		1948
494	125	I.R.	XRB	75	3/60	277	—
464	100	I.R.	ES-1	75	3/60	300	1950
368	100	I.R.	ER-1	60	3/60	277	Late
250	2500	Worth.	3 stg.	175	3/440	257	Late
218	200	I.R.	40	50	3/60	870	Late
211	100	I.R.	E.S.	40	3/60	325	1948
174	125	Worth.	H	30	3/60	300	1940
173	100	I.R.	E.R.	30	3/60	300	1945
78	350	I.R.	ES-2	30	3/60	300	1954
8.8	2500	I.R.	ES-2	20	3/60	350	1945

"Everything from a Pulley to a Powerhouse"

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R. M. REGISTERED U. S. PATENT OFFICE

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• Cable Address OBRIEN PHILA.

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Circle 527 on Reader Service Card

POWER EQUIPMENT

15000 KW, *NEW*, Cond. Turbo-Generator 3/60, 13800 V, 3600 RPM, 850 PSIG, 900°TT with boiler.

2500 KW, G.E., Non C. Turbo-Gen. 3/60, 480 V., 3600 RPM, 180 PSIG, 10 PSIG Exh.

2000 KW, Allis, Non-C. Turbo-Gen. 3/60, 480 V., 3600 RPM, 180 PSIG, 10 PSIG Exh.

1500 KW, Elliott, Cond. Turbo-Gen. 3/60, 2300 V, Geared 5000/1200 RPM 250 PSIG, 525°TT

1000 KW, G.E., Non C. Turbo-Gen. 3/60, 2300 V, 3600 RPM, 400 PSIG 600°TT, 90-125 PSIG Exh.

300 KW, .60 PF, G.E. Cond. Turbo-Gen 3/60, 2300 V, 5917/1200 RPM, 400 PSIG, 600°TT, geared.

1000 KW, G.M. 16-278A, Diesel Units (2) 3 Ph. 60 cycle, 2300 V, 720 RPM

300 KW, G.M., 8-268A, Diesel Units (2) 3 Ph. 60 cycle, 480 V, 1200 RPM

500 KW, .8 PF, West. 3/60, 240/480 V. 300 RPM, Gen. direct conn. to Ames Vertical Uniflow Engine.

BREW, WOLTMAN
& COMPANY, INC.
50 CHURCH ST., N.Y. 7, N.Y.

Circle 528 on Reader Service Card

TRANSFORMERS—60 CYCLE

QU.	KVA	MAKE	TYPE	PHASE	VOLTAGE
2	3000	Moloney	TCR	3	7200-4160/2400
2	3000	G.E.	OA-T	3	26,400-4160/2400
1	1500	West.	O.I.S.C.	3	26,400-480 taps-hi
1	300	Penna.	OA Askarel	3	12,470Y/7200-240
3	200	Amer.	C.C.	1	4160/7200-240/480
3	200	G.E.	HS-W28	1	2400/4160-240/480
3	100	Wagner	HE	1	2300/4160-220/440
3	75	G.E.	H-form KF	1	2400/4160Y-120/240
3	50	G.E.	H-form K	1	2400/4160Y-220/440
3	50	Niagara	Dry-air	1	2400/4160Y-120/240
3	50	Harrison	Dry-air	1	2400/4160Y-220/440

MOTOR GEN. SETS

QU.	KW	MAKE	SPEED	D.C.	A.C.
1	1000	West.	720	600	2300/4160 S.R.
1	400	West.	1200	250/125	3 unit 4160 V. syn.
1	300	G.E.	1200	250	2300/4160 syn.
1	300	Al. Ch.	1200	125/250	3 unit 440 syn.
1	175	West.	1200	125	4160 syn.
1	100	West.	900	230	4160 syn.
1	45	G.E.	1170	440	Sq. Cage
1	30	G.E.	1760	220/440	Sq. Cage

D.C. MOTORS — 230 VOLT

QU.	HP	MAKE	SPEED	TYPE
1	350	G.E.	1200	ped. type
1	30	West.	1750	SK-113
1	30	G.E.	2200	CD-85
1	15	Crocker Wh	1750	CCM, TEFC

SLIP RING MOTORS

QU.	HP	MAKE	SPEED	TYPE	VOLTS
1	500	G.E.	1200	M369Z	2200/4160
1	500	G.E.	450	MT 422Y	2200
1	450	West.	1800	CW 4-30-9	220
1	350	West.	1800	CW	2300
1	300	G.E.	1170	1-15 A	4150
1	200	West.	585	CW	440
3	150	Al. Ch.	1760	AY-RW	2300
2	150	G.E.	500	1-16	4000
1	100	West.	1770	TEFC B.B.	220/440
1	75	West.	1160	CW 607	220/440
1	75	West.	600	CW 774C	220
1	50	G.E.	570	MT 552	220/440

SQUIRREL CAGE MOTORS—3 phase—60 cyc.

QU.	HP	MAKE	SPEED	TYPE	VOLTS
1	300	Al. Ch.	1200	ARW	2200
1	275	G.E.	1180	KT 559BS	2200
2	250	G.E.	1790	KTEFC B.B.	2300
2	150	G.E.	1780	K 6325-S XP B.B.	440
2	100	Cont.	3570	NP 585-S XP B.B.	440
1	100	West.	1185	CSP 5808 B.B. drip	440/220
1	75	Cont.	3565	NP5058X XP B.B.	440
1	75	G.E.	875	KT 559Y	440
1	50	G.E.	3530	KF 405Y Vert.	220/440
1	50	Cont.	3530	NP 445X XP B.B.	220/440

MOTORS—SYNCHRONOUS 3 ph, 60 cyc.

HP	SPEED	MAKE	TYPE	VOLTS
325	900	West.		2300
400	450	West.	HR	440
300	720	El. Mh. TEFC		2300
200/100	720/360	West.		4150
150	3600	G.E.	TS 956Y drip	2300
150	1800	G.E.	TS	220/440
150	900	West.		220/440
125	900	G.E.	TS 7536	2200
125	600	G.E.	TS 7641	2200
75	1200	Cr. Wh.	ALT B.B.	220/440

FOR POWER

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1602 54th STREET, NORTH BERGEN, N. J.

PHONE NEW YORK - LONGACRE 5-3227

PHONE NEW JERSEY - UNION 1-2600

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Installed but never used
Built of finest materials

WESTINGHOUSE 1250 K.W. TURBO-GENERATORS

(4)—Westinghouse—440/3/60—850°—540 lbs. working pressure. Complete with condensers, circulating pumps, etc.

BOILERS

7 B&W EXPRESS TYPE

Design pressure 634# — operating pressure 565# — temp. 850°F. Oil fired — separately fired superheaters. *Capacity: 210,000 lb.* steam/hr. ideal for testing where large quantities of steam are required, giving excellent control from separately fired superheaters. Can be converted for #2 oil and natural gas. Fully automatic.

LARGE DEAERATING FEED HEATERS

Monel construction — spray type — capacity 480,000 lbs./hr.—vent condenser—single pass —heating surface 174 sq. ft.—all Monel construction.

GE HIGH AND LOW PRESSURE MAIN PROPELLING TURBINES

Will sell separately for testing, wind tunnel or similar work. (2) high pressure—24,400 HP—12 impuse stages—4909 RPM—working pressure 540 lbs.—825°F. (2) low pressure—28,600 HP — 3913 RPM — working pressure 49 lbs. steam—424°F—2-6 stages of impulse.

FEED PUMPS

Ingersoll-Rand—5"—three stage—500 GPM at 750 lb. discharge. BHP 330—5000 RPM—Worthington turbine—573 lbs.—non-condensing—back pressure 20 lbs.

FORCED DRAFT BLOWERS

29,000 CFM—max. static 35"—normal 21".

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THE BOSTON METALS CO.

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ELGIN 5-5050 — LEXINGTON 9-1900

Circle 531 on Reader Service Card

FOR SALE

1050 KVA DIESEL UNIT

1050 KVA Nordberg supercharged diesel engine generator unit, 3 phase, 60 cycle 2400 volts, 327 RPM.

New 1947 — Excellent condition.

The above unit is still installed and complete with all auxiliaries as in operation. Can be adapted for dual fuel operation.

International Power Machinery Co.
1612 Union Commerce Bldg.—MAin 1-9514
Cleveland 14, Ohio

Circle 529 on Reader Service Card

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The meeting place of Used Equipment Buyers and Sellers

Advertisers' Index

A

Air Preheater Corp. 123
Allegemeine Elektricitats-Gesellschaft ..... *
Allis-Chalmers Mfg. Co. ..... *
Allpax Company, Inc. ..... *
American Engineering Co. ..... *
American Gilsonite Co. ..... *
American Meter Co.
Pump Div. ..... *
American Pulverizer Co. 142
American Standard
Industrial Div. 87
Ames Iron Works, Inc. ..... *
Anaconda American Brass Co. 128
Anchor Packing Co. 121
Anderson Co., V. D. ..... *
Armstrong Cork Co. 26
Armstrong Machine Works 151
Asea Electric, Inc. ..... *
Associated Electrical Ind. Export, Ltd. ..... *
Atomics International
A Div. of North American Aviation, Inc. 157
Aurora Pump Div.
New York Air Brake Co. 40

B

Babbitt Steam Specialty Co. ..... *
Babcock & Wilcox Co.
Boiler Div. 4-5
Babcock & Wilcox Co.
Refractories Div. ..... *
Badger Mfg. Co. ..... *
Bailey Meter Co. 10-11
Barco Manufacturing Co. ..... *
Barnes & Jones, Inc. ..... *
Beaird Co., Inc., J. B. ..... *
Bell & Gossett Co. ..... *
Belmont Packing & Rubber Co. 124
Biddle Co., James G. 140
Black, Sivalls & Bryson, Inc. 119
Boiler Tube Co. of America 118
Bonney Forge & Tool Works 174
Borg-Warner Mechanical Seals ..... *
Breuer Electric Mfg. Co. ..... *
Bridgeport Brass Co. ..... *
Brown Company ..... *
Buell Engineering Co. ..... *
Buffalo Forge Co. 125
Bussmann Mfg. Div.
McGraw Edison Co. ..... *
Butler Manufacturing Co. ..... *
Byron Jackson Pumps, Inc.
Sub. of Borg Warner Corp. ..... *

C

Carling Turbine Blower Co. ..... *
Catawissa Valve & Fittings Co. 158
Chart-Pak, Inc. ..... *
Chase Brass & Copper Co. ..... *
Chesapeake & Ohio Railway ..... *
Chesterton Co., A. W. 100
Chicago Pneumatic Tool Co. 20-21
Clarage Fan Co. 97
Clark Bros.
One of the Dresser Industries ..... *
Clayton Manufacturing Co. 47
Cleaver-Brooks Company ..... *
Cochrane Division
Crane Company ..... *
Colonial Plastics Mfg. Co. ..... *
Combustion Engineering, Inc. 30-31
Condenser Service & Engrg. Co. ..... *
Consolidated Diesel Electric Corp. ..... *
Cooper-Bessemer Corp. 110-111
Copes-Vulcan Div.
Blaw-Knox Company 14-15
Coppus Engineering Corp. ..... *
Corning Glass Works ..... *
Crane Company 108, 109
Crane Packing Co. 104
Crawford Fitting Co. ..... *
Croll Reynolds Engrg. Co., Inc. ..... *

D

Davey Compressor Co. ..... *
Dearborn Chemical Co. 1
DeLaval Steam Turbine Co. ..... *
DeVar Systems Inc.
Div. of General Kinetics Inc. 134
Detroit Stoker Company 159
Diamond Power Specialty Corp. 6-7
Dodge Manufacturing Corp. 52
Dow Chemical Co. ..... *
Dow Corning Corp. ..... *
Dow Industrial Service
Div. of Dow Chemical Co. 38
Dravo Corp.
Grating Div. ..... *
duPont de Nemours & Co., Inc. E. I.
Industrial & Biochemicals Dept. ..... *
duPont de Nemours & Co., Inc., E. I.
Polychemicals—Teflon 179

E

Eastern Gas & Fuel Associates 34-35
Edison Industries, Thomas A.
Instrument Div. ..... *
Edward Valves, Inc. 42-43
Electric Machinery Mfg. Co. 98
Electric Storage Battery Co. 175
Elgin Softener Corp. 50
Elliott Company ..... *
Elliott Company—Lagonda Plant 160, 167
Elliott Company—Roto Plant 106
Engineer Company 180
Erie City Iron Works ..... *
Everlasting Valve Co. ..... *

F

Fairbanks, Morse & Co. 44-45, 143
Fairmont Chemical Co. ..... *
Field Control Div.
Conco Engrg Works, Inc. 148
Fisher Governor Co. 120, 182
Flexitallic Gasket Co. 51
Flexonics Corp. 99
Fluor Products Co. 181
Foster Wheeler Corp. 126-127
Foxboro Company ..... *
Frick Company ..... *
Fuller Company 173

G

Garden City Fan & Blower Co. 146
Gardner-Denver Co. ..... *
Garlock Incorporated 141, 165
General Controls ..... *
General Electric Co. ..... *
General Precision, Inc.
Kearfott Division 132
Goulds Pumps, Inc. 139
Graver Water Conditioning Co. ..... *
Green Fuel Economizer Co. ..... *
Grinnell Company ..... *
Gustin-Bacon Mfg. Co. ..... *

H

Hagan Chemical & Controls, Inc. ..... *
Hall Laboratories ..... *
Hamon, Inc. ..... *
Hitachi, Ltd. 58
Hoffman Specialty Mfg. Corp. 147
Hungerford & Terry, Inc. 146
Hupp Aviation Div.
Hupp Corp. 27

I

I-T-E Circuit Breaker Co. 28
Illinois Water Treatment Co. 108
Industrial Combustion, Inc. 96
Infilco Inc. ..... *
International Boiler Works Co. 166
International Heating &
Air Conditioning Exposition ..... *
International Nickel Co., Inc.
Huntington Alloy Products Div. ..... *
International Salt Co. ..... *
Iron Fireman Mfg. Co. 107

J

Jenkins Bros 56-57
Jerguson Gage & Valve Co. ..... *
Johns Hopkins Press 120
Johns-Manville 32
Johnson Service Co. ..... *

K

Keasbey & Mattison Co. ..... *
Keeler Co., E. ..... *
Kerrigan Iron Works Co. ..... *
Kieley & Mueller, Inc. ..... Third Cover
Kirk & Blum Mfg. Co. 162
Koppers Co., Inc.
Electrostatic Precipitators 135
Kuljian Corp. ..... *

L

Limitorque Corp. ..... *
Link-Belt Company ..... *
Liquidometer Corp. ..... *
Lunkenheimer Company ..... Second Cover

M

Madden Corp. 168
Manning, Maxwell & Moore, Inc. 22-23
Mansfield & Green, Inc. ..... *
Marley Company 41
Marsh Instrument Company
Div. of Colorado Oil & Gas Corp. 91
Mason-Neilan
Div. of Worthington Corp. 18-19
McDonnell & Miller, Inc. 164
McGraw-Hill Book Co. 169-170-171
Meaker Company
Sub. of Sel-Rex Corp. 39
Mears Kane Ofeldt, Inc. ..... *
Mercoid Corp. 144
Metropolitan Refining Co. 176
Michigan Seamless Tube Co.
Gulf States Tube Corp. 37
Midwest Piping Co., Inc. ..... *
Minneapolis-Honeywell 48-49
Morton Salt Co.
Industrial Div. ..... *
Murray Iron Works Co. ..... *
Murray Mfg. Co., D. J. ..... *

This index is a service to readers. Every effort is made to maintain its accuracy, but POWER cannot assume responsibility for errors or omissions. When a star appears after the name, the advertisement does not appear in this issue but appeared in an issue within the previous three months.

N

Nalco Chemical Co. ... *
National Tube Div. of U.S. Steel ... *
Nicholson & Co., W. H. ... 114
Nordberg Manufacturing Co. ... 29
North American Mogul Products Co. ... *
Norwalk Company, Inc. ... *

O

OPW-Jordan Corp. ... *
Ohio Brass Company ... *
Ohio Injector Co. ... 161
Onan Division Studebaker-Packard Corp. ... 16-17
Orr & Sembower, Inc. ... *

P

Patterson-Kelley Co. ... 163
Peabody Engineering Corp. ... 117
Peerless Pump, Hydrodynamics Div. Food Machy. & Chemical Corp. ... 36
Penberthy Mfg. Co. ... 122
Pennsylvania Crusher Div. Bath Iron Works Corp. ... 133
Pennsylvania Flexible Metallic Tubing Co. ... *
Pennsylvania Pump & Compressor Co. ... *
Pfaudler Permutit, Inc. ... 116
Pfizer & Co., Inc., Charles Chemical Sales Div. ... *
Phelps Dodge Copper Products Corp. ... 24-25
Philadelphia Gear Corp. ... *
PIC Design Corp. ... *
Pipe Fabrication Institute ... 144, 145
Pittsburgh Plate Glass Co. Fiber Glass Div. ... *
Plibrico Company ... *
Powell Co., Wm. ... 54
Powers Regulator Co. ... 95
Pratt Company, Henry ... *

R

R-P & C Valve Div. Amer. Chain & Cable Co., Inc. ... 105
Raybestos-Manhattan, Inc. Manhattan Rubber Div. ... 90
Raybestos-Manhattan, Inc. Packing Div. ... 156
Reliance Gauge Column Co. ... 172
Republic Flow Meters Co. ... 154, 155
Republic Steel Corp. ... 12-13
Research-Cottrell, Inc. ... *
Revere Copper & Brass Inc. ... 214
Ric Wil Incorporated ... *
Ridge Tool Company ... 178
Riggio Co., Inc., Frank D. ... *
Riley Stoker Corporation ... 84-85
Robvon Backing Ring Co. ... *
Rohm & Hass Co. ... 136

S

Sarco Company, Inc. ... 204
Sargent & Lundy Engineers ... *
Schaub Engineering Co., Fred H. ... *
Schoonmaker Co., Inc., A. G. ... *
Scovill Mfg. Co. ... *
Smith Corp., A. O. ... 118
Southwestern Engrg. Co. ... *
Spence Engineering Co. ... 137
Stephens-Adamson Mfg. Co. ... *
Stickle Steam Specialties Co. ... *
Stock Equipment Co. ... *
Superior Combustion Industries, Inc. ... 115

T

Technicon Controls, Inc. ... *
Terry Steam Turbine Co. ... 89
Thermo Electric Co., Inc. ... 46

U

Union Asbestos & Rubber Co. Fibrous Products Div. ... *
Union Iron Works ... *
United Engineers & Constructors Inc. ... *
United States Motors Corp. ... 33
United States Rubber Co. Textile Div. ... *
Universal Atlas Cement Div. of U.S. Steel ... 149

V

Valley Camp Coal Co. ... 103
Van Products Co ... 158
Viking Pump Co. ... 148
Vogt Machine Co., Henry ... 94

W

Wallace & Tiernan, Inc. ... *
Weir Chicago Bridge, Inc. ... *
Western Chemical Co. ... *
Western Precipitation Corp. ... *
Westinghouse Electric Corp. ... *
Westinghouse Electric Corp. Sturtevant Div. ... *
Where to Buy ... 205
Wickes Boiler Co. ... *
Wiedeke Co., Gustav ... *
Williams Gauge Co. ... 168
Wolverine Tube Div. of Calumet & Hecla, Inc. ... *
Worthington Corp. ... Back Cover
Wright-Austin Co. ... *

Y

Yarnall-Waring Company ... 8-9, 177
Yuba Consolidated Industries, Inc. ... 53

Z

Zallea Brothers ... *

Professional Services ... 205

CLASSIFIED ADVERTISING

F. J. Eberle, Business Mgr.

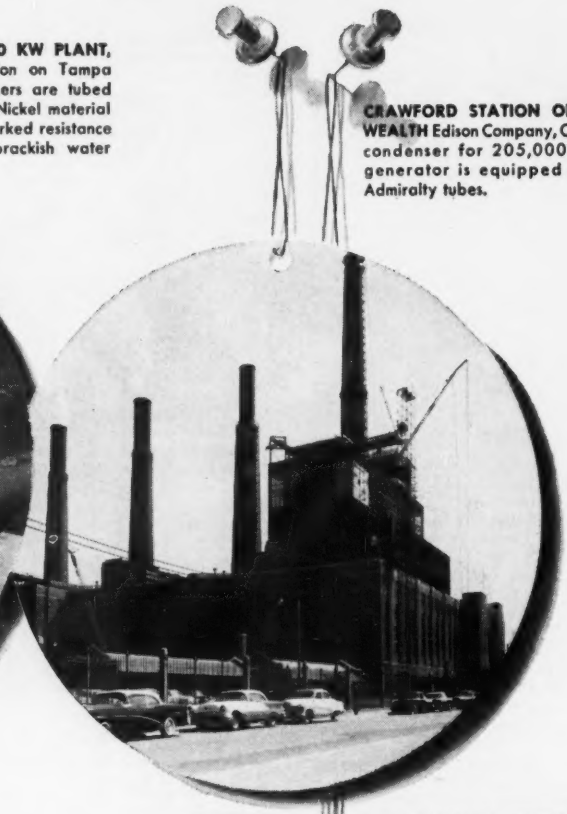
EMPLOYMENT OPPORTUNITIES ... 206
SPECIAL SERVICES ... 207
EQUIPMENT (Used or Surplus New) For Sale ... 207-211
WANTED Equipment ... 207

ADVERTISERS' INDEX

Ajax Electric Motor Corp. ... 207
Allied Electric Co. ... 207
American Air Compressor Corp. ... 208
Ampower ... 206
Belyea Co., Inc. ... 209
Boston Metals Co. ... 208, 209, 210, 211
Brew, Woltman and Co., Inc. ... 211
Chicago Electric Co. ... 209
Ebasco International Corp. ... 208
Electric Equipment Co. ... 208
Electric Service Co. ... 210
Euclid Engineering Corp. ... 210
Hall and Co., Stephen ... 210
Harvey Aluminum, Inc. ... 206
Heat & Power Co., Inc. ... 207
Hemphill and Co., J. L. ... 211
Indeck Power Equipment Co. ... 208
International Power Machinery Co. ... 211
Karpf, A. E. ... 207
Midwest Boiler and Turbine Co. ... 210
O'Brien Machinery Co. ... 211
Pelnik-Loconti Industrial Supply ... 208
Perry Equipment Co. ... 209
Power Equipment Co. ... 209
Shawano Paper Mills ... 207
Universal Power Engineering Co. ... 208
Wabash Power Equipment Co. ... 210
Wagner Company, Arthur ... 208
Weaver Inc., Charles ... 207
Westinghouse Atomic Power Division ... 206
Whisler Equipment Co. ... 208
White Electric Motors ... 208
Zia Company, The ... 206

TUBED BY REVERE MEANS TUBED TO LAST

A. W. HIGGINS 135,000 KW PLANT, Florida Power Corporation on Tampa Bay. Here all 3 condensers are tubed with Revere 10% Cupro-Nickel material because of this alloy's marked resistance to corrosion from the brackish water encountered.



CRAWFORD STATION OF COMMONWEALTH Edison Company, Chicago, where condenser for 205,000 kw. turbine generator is equipped with Revere Admiralty tubes.

A few more power companies who depend on REVERE Tubes for performance plus service

Revere's Technical Advisory Service, because of its long and varied experience, is qualified to help in the selection of the alloy best suited to the specific set of operating conditions encountered in *your* power plant. This experience, which has covered many and varied types of problems, has been instrumental in prolonging tube life for power plants both large and small.

Why not take advantage of this storehouse of knowledge and contact Revere before making the final selection of tubes and plates for your equipment?

REVERE COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue
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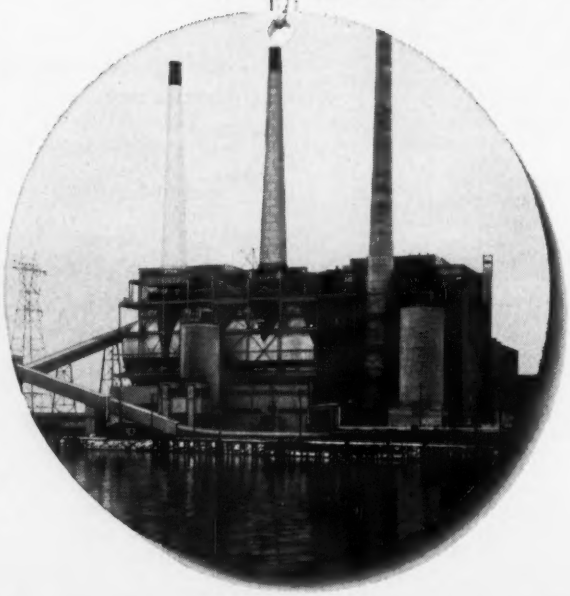


ALLIS-CHALMERS CONDENSER serving the new 265,000 kw. turbine generator Unit #2 River Rouge Station, Detroit Edison Company contains 249,000 lbs. of Revere Admiralty condenser tubes. Tube sheets are Revere Muntz Metal. A lasting combination!

Like you, George Chinn is a perfectionist

As K & M's Chief Engineer, George Chinn might be expected to be at least somewhat biased in his opinion of the valves we make. He isn't. Ask him about our products and he'll tell you that they're "not bad".

For George, this is saying quite a lot. We doubt if any customer could be as critical. In fact, if you were to watch him midwifing a prototype run-through on the test loop, you'd probably wonder if he weren't secretly in the pay of a competitor, so diligently does he poke around looking for something wrong. And with twenty-five years of valve engineering behind him, he knows just where to look, too.

More often than not, he finds a few unsuspected bugs. When he does, we are, honestly, almost glad. Not that we enjoy headaches or have anything against showing a profit. It's just that we'd rather find the flaws, if any exist, than have our customers find them. Makes sense, doesn't it?

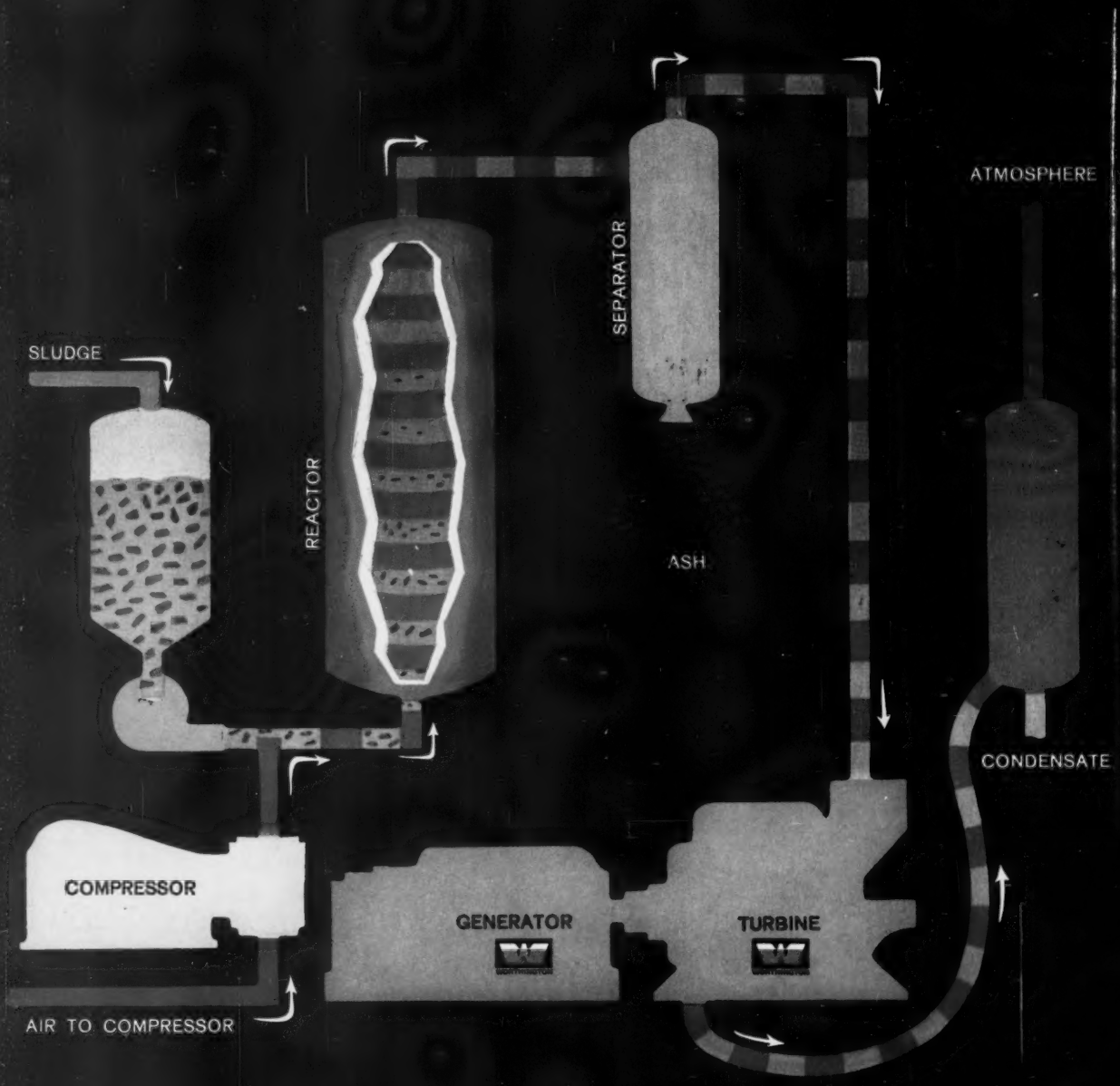
diaphragm control valves

KIELEY & MUELLER, INCORPORATED

64 Genung Street, Middletown, New York

Eighty-two Years of Service to the Process and Power Industries

For more facts circle 202 on Reader Service card, p 101



Worthington turbine generator and Zimmermann process produce...

FREE POWER FROM WASTE

Take nearly any combustible organic waste in aqueous solution. Then react it with air under high pressure. Then use the resulting gas and steam mixture to drive a Worthington power recovery turbine. With sufficient organic content you'll get enough power to run the disposal process—and in some instances a great deal more, too.

In Chicago a $12 million plant built on this Zimmermann Process* will dispose of 200 tons a day (dry basis) of sewage sludge. But the process runs equally well on many industrial organic wastes; for example, waste pulp liquor from a pulp mill and on much smaller tonnage than the large Chicago installation.

Key factor in process efficiency is the direct power recovery from gas-steam mixture produced by the reaction. In the Chicago installation, this mixture will drive a Worthington 12,500 kw. turbine generator.

Why was the Worthington turbine generator unit chosen? Because Worthington turbine specialists lead in designing turbines for power recovery from any gas mixture, including the gas-steam produced here. Because a Worthington generator has quality not exceeded by any other generator manufacturer today. And because of Worthington's reputation for extreme reliability in the industrial turbine field.

For further information about any power recovery turbine application, write or call Worthington Corporation, Turbine Division, Dept. 48-13, Wellsville, New York.

*The Zimmermann Process is patented and licensed by Sterling Drug Inc., N. Y. C., N. Y.

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